

A.2.5 LOWER COLUMBIA RIVER CHINOOK SALMON

A.2.5.1 Summary of Previous BRT Conclusions

The status of Lower Columbia River chinook was initially reviewed by NMFS in 1998 (Myers et al. 1998) and updated in that same year (NMFS 1998). In the 1998 update, the Biological Review Team (BRT) noted several concerns for this ESU. The 1998 BRT was concerned that there were very few naturally self-sustaining populations of native chinook salmon remaining in the Lower Columbia River ESU. Naturally reproducing (but not necessarily self-sustaining) populations identified by the 1998 BRT were the Lewis and Sandy Rivers “bright” fall runs and the “tule” fall runs in the Clackamas, East Fork Lewis and Coweeman Rivers. These populations were identified as the only bright spots in the ESU. The few remaining populations of spring chinook salmon in the ESU were not considered by the previous BRT to be naturally self-sustaining because of either small size, extensive hatchery influence, or both. The previous BRT felt that the dramatic declines and losses of spring-run chinook salmon populations in the Lower Columbia River ESU represented a serious reduction in life-history diversity in the region. The previous BRT felt that the presence of hatchery chinook salmon in this ESU posed an important threat to the persistence of the ESU and also obscured trends in abundance of native fish. The previous BRT noted that habitat degradation and loss due to extensive hydropower development projects, urbanization, logging and agriculture threatened the chinook salmon spawning and rearing habitat in the lower Columbia River. A majority of the previous (1998) BRT concluded that the Lower Columbia River ESU was likely to become endangered in the foreseeable future. A minority felt that chinook salmon in this ESU were not presently in danger of extinction, nor were they likely to become so in the foreseeable future.

Current Listing Status: threatened

A.2.5.2. New Data and Updated Analyses

New data acquired for this report includes spawner abundance estimates through 2001, new estimates of the fraction of hatchery spawners and harvest estimates. In addition, estimates of historical abundance have been provided by WDFW. Information on recent hatchery releases was also obtained. New analyses include the designation of relatively demographically independent populations, recalculation of previous BRT metrics with additional years data, estimates of median annual growth rate (λ) under different assumptions about the reproductive success of hatchery fish, and estimates of current and historically available kilometers of stream.

Historical population structure—As part of its effort to develop viability criteria for LCR chinook, The Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Myers et al. hypothesized that the ESU historically consisted of 20 fall-run populations (“tules”), two late fall-run populations (“brights”) and nine spring-run populations for a total of 31 populations (Figures A.2.5.1 and A.2.5.2). The populations identified in Myers et al. are used as the units for the new analyses in this report.

The WLC-TRT partitioned LCR Chinook populations into a number of “strata” based on major life-history characteristics and ecological zones (McElhany et al. 2003). The WLC-TRT concludes that a viable ESU would need multiple viable populations in each of these strata. The strata and associated populations are identified in Table A.2.5.1.

Table A.2.5.1. Historical population structure and abundance statistics for Lower Columbia River chinook populations. The populations are partitioned into ecological zones and major life history types. The ecological zones are based on ecological community and hydro-dynamic patterns and life history types are based on traits related to run timing. Time series used for the summary statistics are referenced in Appendix A.5.2. Natural-origin spawners had parents that spawned in the wild as opposed to hatchery-origin fish whose parents were spawned in a hatchery.

Life History	Eco-logical Zone	Population	Years for Recent Means	Total Spawners		Natural-origin Spawners		Recent Average Hatchery-origin Spawners (%)
				Recent Geometric Mean	Recent Arithmetic Mean	Recent Geometric Mean	Recent Arithmetic Mean	
Fall Run	Coastal	Youngs Bay Fall Run	No Data					
		Grays River Fall Run	1997-2001	99	152	59	89	38
		Big Creek Fall	No Data					
		Elochoman River Fall	1997-2001	676	1074	186	289	68
		Clatskanie River Fall	No Data					
		Mill, Aber., Germany Fall	1997-2001	734	1197	362	626	47
		Scappoose Creek Fall	No Data					
	Cascade	Coweeman Fall	1997-2001	274	469	274	469	0
		Lower Cowlitz Fall	1996-2000	1,562	1,626	463	634	62
		Upper Cowlitz Fall	2001	5,682				No Data (assumed high)
		Toutle River Fall	No Data					
		Kalama River Fall	1997-2001	2,931	3,138	655	1,214	67
		Salmon Crk/ Lewis Fall	1997-2001 (East Fork Data only)	256	294	256	294	0

Life History	Eco-logical Zone	Population	Years for Recent Means	Total Spawners		Natural-origin Spawners		Recent Average Hatchery-origin Spawners (%)	
				Recent Geometric Mean	Recent Arithmetic Mean	Recent Geometric Mean	Recent Arithmetic Mean		
		Clackamas River Fall	1998-2001	40	56	No Data			
		Washougal River Fall	1997-2001	3,254	3,364	1,130	1,277	58	
		Sandy River Fall	1997-2001	183	216	No Data			
		Lower Gorge Trib. Fall	No Data						
	Gorge	Upper Gorge Trib. Fall	1997-2001 (Wind River Data only)	136	216	109	198	13	
		Hood River Fall	1994-1998	18	21	No Data			
		Big White Salmon Fall	1997-2001	334	602	218	462	21	
		Sandy Late Fall	1997-2001	504	773	778	750	3	
	Late Fall (bright)	N.F. Lewis Late Fall (bright)	1997-2001	7,841	8,834	6,818	7,828	13	
Spring Run		Cascade	Upper Cowlitz Spring	2001	1,787		No Data		
	Cispus River Spring								
	Tilton River Spring								
	Toutle River Spring		No Data						
	Kalama River Spring		1997-2001	98	185	No Data			
	Lewis River Spring		1997-2001	347	363	No Data			
	Sandy River Spring		No Data						
	gorge	Big White Salmon Spring	No Data (No fish?)						
		Hood River Spring	1994-1998	51	61	No data			

Abundance and trends

Data sources for abundance time series and related data are in Appendix A.5.2. The recent abundance of both total and natural-origin spawners, and recent fraction of hatchery-origin spawners for LoCR Chinook populations are summarized in Table A.2.5.1. Natural-origin fish had parents that spawned in the wild as opposed to hatchery-origin fish whose parents were spawned in a hatchery. The abundances of natural-origin spawners range from near extirpation for most of the spring run populations to over 7,841 for the Lewis River bright population. The majority of the fall-run tule populations have a substantial fraction of hatchery-origin spawners in the spawning areas and may be sustained largely by hatchery production. Exceptions are the Coweeman population and the East Fork Lewis portion of the Lewis River/Salmon Creek population, which have few hatchery fish spawning on the natural spawning areas. These two populations have recent geometric mean natural-origin abundance estimates of 274 and 256 spawners respectively. Although quantitative information is not yet available, preliminary examination of scales indicates that almost all current spring run spawners in the Washington part of this ESU are of hatchery origin (Rawding, pers. comm.) The majority of the spring run populations have been extirpated largely as the result of dams blocking access to their high elevation habitat. The two bright chinook populations (i.e., Lewis and Sandy) have relatively high abundances, particularly the Lewis.

Access to the habitat of the historical Upper Cowlitz, Cispus, and Tilton Rivers populations is blocked by the Mayfield, Mossy Rock and Cowlitz Falls dams. A relatively large number of both spring and fall Chinook are currently released as part of a reintroduction program to establish chinook above Cowlitz Falls dam (Serl and Morrill 2002). The adults for the reintroduction program are collected at the Cowlitz Salmon hatchery and the vast majority of the chinook trucked above Cowlitz Falls are believed to be of hatchery origin, though marking of hatchery fish is not complete and a quantitative assessment has not been undertaken. Downstream survival of juvenile chinook though the dams and reservoirs is considered negligible, so juveniles are collected at Cowlitz Falls and trucked downstream. The current collection efficiency of juveniles at Cowlitz Falls is considered too low for the reintroduction to be self-sustaining (Rawding 2003 pers. comm.).

Where data are available, the abundance time series information for each of the populations is presented in Figures A.2.5.3-A.2.5.30. Three types of time series figures are presented. The first type of figure plots abundance against time (Figures A.2.5.3, A.2.5.4, A.2.5.5, A.2.5.6, A.2.5.8, A.2.5.10, A.2.5.12, A.2.5.14, A.2.5.16, A.2.5.18, A.2.5.20, A.2.5.21, A.2.5.22, A.2.5.24, A.2.5.25, A.2.5.26, and A.2.5.27). Where possible, two lines are presented on the abundance figure, where one line is the estimated total number of spawners and the other line is the estimated number of fish of natural origin. In many cases, data were not available to distinguish between natural- and hatchery-origin spawners, so only total spawner information is presented. This type of figure can give a sense of the levels of abundance, overall trend, patterns of variability, and the fraction of hatchery-origin spawners. A high fraction of hatchery-origin spawners indicates that the population may potentially be sustained by hatchery production and not the natural environment. It is important to note that estimates of the fraction of hatchery-origin fish are highly uncertain since the hatchery marking rate for LCR fall chinook is generally only a few percent and expansion to population hatchery fraction is based on only a handful of recovered marked fish (unpublished analysis, McElhany, Rawding, and Sydor). The second type

of time series figure displays fish per mile data. For three populations of fall run chinook in Oregon watersheds, total abundance estimates are not available, but fish per mile time series exists (Figures A.2.5.28-A.2.5.30). There are no estimates of the fraction of hatchery-origin spawners in these fish/mile time series, but the percentage may be high given the large number of hatchery fish released and the high fraction of hatchery-origin spawners estimated in Washington watersheds directly across the Columbia River. The lack of information on hatchery fraction reduces the value of these time series for evaluating extinction risk.

The third type of time series figure presents the total number of spawners (natural and hatchery origin) and the estimated number of preharvest recruits produced by those spawners against time (Figures A.2.5.7, A.2.5.7.9, A.2.5.7.11, A.2.5.13, A.2.5.15, A.2.5.17, A.2.5.19, A.2.5.23). Dividing the number of preharvest recruits by the number of spawners for the same time period would yield an estimate of the preharvest recruits per spawner for the broodyear. Spawner are taken as the sum of hatchery and natural-origin spawners. This type of figure requires harvest and age structure information and therefore could be produced for only a limited number of populations. This type of figure can indicate whether there have been changes in preharvest recruitment and the degree to which harvest management has the potential to recover populations. If the preharvest recruitment line is consistently below the spawner line, it indicates that the population would not be replacing itself, even in the absence of all harvest.

Summary statistics on population trends and growth rate are presented in Tables A.2.5.2-A.2.5.4. The methods for estimating trends and growth rate (λ) are described in the general method section. Trends are calculated on total spawners, both hatchery and natural origin. The λ estimate is calculated under two different assumptions about the reproductive success of hatchery-origin spawners. In one analysis, hatchery-origin spawner are assumed to have zero reproductive success and in the other analysis, hatchery-origin spawners are assumed to have a reproductive success equal to that of natural-origin spawners. Because λ is only calculated for time series where the fraction of hatchery-origin spawners is known, most of the long-term trend estimates use data starting in 1980, even though the abundance time series of total spawners may extend earlier than 1980. The majority of populations have a long-term trend less than one, indicating the population is in decline. In addition, there is a high probability for most populations that the true trend/growth rate is less than one (Table A.2.5.4). However, in general there is a great deal of uncertainty about the growth rate, as indicated by the large confidence intervals. The uncertainty about growth rate is generally higher for chinook than for other LCR anadromous salmonids because of the high variability observed in the time series. A negative long-term growth rate is indicated for all of the populations except the Coweeman fall run when analyzed under the assumption that hatchery-origin fish have a reproductive success equal to natural-origin fish. The Coweeman fall run had very few hatchery-origin spawners (Table A.2.5.2). The potential reasons for these declines have been cataloged in previous status reviews and include habitat degradation, overharvest, deleterious hatchery practices, and climate-driven changes in marine survival.

The Lewis River bright population is considered the healthiest in the ESU. The population is significantly larger than any other population in the ESU, and, in fact, it is larger than any population of salmon in the Columbia Basin except the Hanford Reach chinook. The Lewis bright chinook harvest has been managed to an escapement target of 5,700 and this target

has been met every year for which data are available except 1999 (Figure A.2.5.16). The preharvest recruits have exceeded spawners in all years for which data are available except two (Figure A.2.5.17). There has been a hatchery program for Lewis River brights, but hatchery-origin spawners have generally comprised less than 10% of the spawning population over the time series. These indicators all suggest a relatively healthy population. However, the long-term population trend estimate is negative (Figure A.2.5.30), and it is not clear the extent to which this reflects management decisions to harvest closer to the escapement goal as compared to declining productivity over the time series. The population is also geographically confined to a reach that is only a few kilometers in length and is immediately below Merwin Dam, where it is affected by the flow management of the hydrosystem. This limited spatial distribution is a potential risk factor.

Table A.2.5.2.. Long-term trend and growth rate for subset of Lower Columbia chinook populations for which adequate data are available (95% C.I. are in parentheses). The long-term analysis used the entire data set. The trend estimate is for total spawners and includes both natural-origin and hatchery-origin fish. The λ calculation is an estimate of what the natural growth rate would have been after accounting for hatchery-origin spawners. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners. In “Hatchery = 0” columns, hatchery fish are assumed to have zero reproductive success. In the “Hatchery = Wild” columns, hatchery fish are assumed to have the same relative reproductive success as natural-origin fish.

Run	Population	Years for Long-term Trend	Long-term Trend of Total Spawners	Years for Long-term λ	Long-term Median Growth Rate (λ)	
					Hatchery = 0	Hatchery = Wild
Fall	Grays River fall-run	1964-2001	0.965 (0.928-1.003)	1980-2001	0.944 (0.739-1.204)	0.844 (0.660-1.081)
	Elochoman River fall-run	1964-2001	1.019 (0.990-1.048)	1980-2001	1.037 (0.813-1.323)	0.800 (0.625-1.024)
	Mill, Abernathy, Germany Creekd fall-run	1980-2001	0.965 (0.909-1.024)	1980-2001	0.981 (0.769-1.252)	0.829 (0.648-1.006)
	Coweeman River fall-run	1964-2001	1.046 (1.018-1.075)	1980-2001	1.092 (0.855-1.393)	1.091 (0.852-1.396)
	Lower Cowlitz River fall-run	1964-2000	0.951 (0.933-0.968)	1980-2000	0.998 (0.776-1.282)	0.682 (0.529-0.879)
	Kalama River fall-run	1964-2001	0.994 (0.973-1.016)	1980-2001	0.973 (0.763-1.242)	0.818 (0.639-1.048)
	Salmon Creek/Lewis River fall-run	1980-2001	0.981 (0.949-1.014)	1980-2001	0.984 (0.771-1.256)	0.979 (0.765-1.254)
	Clackamas River fall-run	1967-2001	0.937 (0.910-0.965)	No Hatchery Fraction Data		

	Washougal River fall-run	1964-2001	1.088 (1.002-1.115)	1980-2001	1.025 (0.803-1.308)	0.815 (0.637-1.045)
	Upper Gorge Tributaries fall-run	1964-2001 (Wind only)	0.935 (0.892-0.979)	1980-2001	0.959 (0.751-1.224)	0.955 (0.746-1.223)
	Big White Salmon River fall-run	1967-2001	0.941 (0.912-0.971)	1980-2001	0.963 (0.755-1.229)	0.945 (0.738-1.210)
Late Fall Run (brights)	Sandy River late fall-run	1984-2001	0.946 (0.880-1.014)	1984-2001	0.943 (0.715-1.243)	0.935 (0.706-1.237)
	North Fork Lewis River late fall-run	1964-2001	0.992 (0.980-1.008)	1980-2001	0.968 (0.756-1.204)	0.948 (0.741-1.214)
Spring Run	Upper Cowlitz River spring-run	1980-2001	0.994 (0.942-1.064)	No Hatchery Fraction Data (presumed high)		
	Kalama River spring-run	1980-2001	0.945 (0.840-1.064)	No Hatchery Fraction Data (presumed high)		
	Lewis River spring-run	1980-2001	0.935 (0.879-0.995)	No Hatchery Fraction Data (presumed high)		

Table A.2.5.3. Short-term trend and growth rate for subset of Lower Columbia chinook populations for which adequate data are available (95% C.I. are in parentheses). Short-term data sets include data from 1990 to the most recent available year. The trend estimate is for total spawners and includes both natural-origin and hatchery-origin fish. The λ calculation is an estimate of what the natural growth rate would have been after accounting for hatchery-origin spawners. The λ estimate is calculated under two hypotheses about the reproductive success of hatchery-origin spawners. In “Hatchery = 0” columns, hatchery fish are assumed to have zero reproductive success. In the “Hatchery = Wild” columns, hatchery fish are assumed to have the same relative reproductive success as natural-origin fish.

Run	Population	Years for Short-term Trend	Short-term Trend of Total Spawners	Years for Short-term λ	Short-term Median Growth Rate (λ)	
					Hatchery = 0	Hatchery = Wild
Fall	Grays River fall-run	1990-2001	1.086 (0.840-1.405)	1990-2001	1.004 (0.787-1.282)	0.898 (0.701-1.150)
	Elochoman River fall-run	1990-2001	1.154 (0.988-1.347)	1990-2001	1.119 (0.877-1.428)	0.869 (0.679-1.113)
	Mill, Abernathy, Germany Creeks fall-run	1990-2001	0.974 (0.833-1.139)	1990-2001	0.993 (0.778-1.268)	0.823 (0.643-1.054)
	Coweeman River fall-run	1990-2001	0.985 (0.816-1.139)	1990-2001	0.977 (0.765-1.247)	0.977 (0.763-1.251)
	Lower Cowlitz River fall-run	1990-2000	1.031 (0.969-1.097)	1990-2000	1.231 (0.873-1.443)	0.782 (0.607-1.009)

	Kalama River fall-run	1990-2001	0.996 (0.898-1.104)	1990-2001	0.944 (0.740-1.205)	0.799 (0.624-1.022)
	Salmon Creek/Lewis River fall-run	1990-2001	1.017 (0.929-1.114)	1990-2001	1.027 (0.805-1.311)	1.027 (0.802-1.315)
	Clackamas River fall-run	1990-2001	0.799 (0.677-0.945)	1990-2001	No Hatchery Fraction Data	
	Washougal River fall-run	1990-2001	1.009 (0.961-1.058)	1990-2001	0.985 (0.722-1.257)	0.769 (0.600-0.989)
	Upper Gorge Tributaries fall-run	1990-2001	1.291 (0.943-1.769)	1990-2001	1.246 (0.976-1.590)	1.235 (0.964-1.581)
	Big White Salmon River fall-run	1990-2001	1.106 (0.899-1.361)	1990-2001	1.057 (0.828-1.348)	1.013 (0.791-1.297)
Late Fall Run (brights)	Sandy River late fall-run	1990-2001	0.915 (0.796-1.052)	1990-2001	0.919 (0.697-1.212)	0.912 (0.689-1.207)
	North Fork Lewis River late fall-run	1990-2001	0.969 (0.889-1.056)	1990-2001	0.966 (0.754-1.236)	0.945 (0.738-1.210)
Spring Run	Upper Cowlitz River spring-run	1990-2001	1.011 (0.891-1.148)	1990-2001	No Hatchery Fraction Data	
	Kalama River spring-run	1990-2001	1.080 (0.880-1.326)	1990-2001	No Hatchery Fraction Data	
	Lewis River spring-run	1990-2001	0.857 (0.783-0.937)	1990-2001	No Hatchery Fraction Data	

Table A.2.5.4. Probability that the long-term abundance trend or growth rate of as subset of Lower Columbia River steelhead populations is less than one. In the “Hatchery = 0” columns, the hatchery-origin fish are assumed to have zero reproductive success. In the “Hatchery = Wild” columns, hatchery-origin fish are assumed to have reproductive success equivalent to that of natural-origin fish.

Run	Population	Long –Term Analysis			Short-Term Analysis		
		Prob. Trend <1	Prob. λ <1		Prob. Trend <1	Prob. λ <1	
			Hatchery =0	Prob. Trend <1		Hatchery =0	Hatchery = Wild
Fall Run	Grays River fall-run	0.965	0.715	0.947	0.245	0.491	0.710
	Elochoman River fall-run	0.099	0.373	0.967	0.033	0.270	0.765
	Mill, Abernathey, Germany Creeks fall-run	0.887	0.581	0.973	0.643	0.514	0.833
	Coweeman River fall-run	0.001	0.194	0.196	0.570	0.556	0.556
	Lower Cowlitz River fall-run	1.000	0.510	0.510	0.148	0.216	0.952

	Kalama River fall-run	0.710	0.612	0.612	0.536	0.704	0.962
	Salmon Creek/ Lewis River fall-run	0.876	0.663	0.663	0.340	0.331	0.331
	Clackamas River fall-run	1.000	No hatchery fraction data		0.993	No hatchery fraction data	
	Washougal River fall-run	0.000	0.323	0.323	0.350	0.556	0.989
	Upper Gorge Tributaries fall-run	0.997	0.612	0.612	0.050	0.137	0.148
	Big White Salmon River fall-run	1.000	0.623	0.623	0.151	0.405	0.476
Late Fall Run (brights)	Sandy River late fall-run	0.994	0.833	0.833	0.906	0.828	0.849
	North Fork Lewis River late fall-run	0.817	0.800	0.800	0.785	0.733	0.841
Spring Run	Upper Cowlitz River spring-run	0.591	No hatchery fraction data		0.423	No hatchery fraction data	
	Kalama River spring-run	0.834	No hatchery fraction data		0.210	No hatchery fraction data	
	Lewis River spring-run	0.993	No hatchery fraction data		0.998	No hatchery fraction data	

Ecosystem Diagnosis and Treatment (EDT) based estimates of historical abundance—The Washington Department of Fish and Wildlife (WDFW) has conducted analyses of the Lower Columbia River chinook populations using the Ecosystem Diagnosis and Treatment (EDT) model (Busack and Rawding 2003). The EDT model attempts to predict fish population performance based on input information about reach-specific habitat attributes (<http://www.olympus.net/community/dungenesswc/EDT-primer.pdf>). WDFW populated this model with estimates of historical habitat condition that produced the estimates of average historical abundance shown in Table A.2.5.5. There is a great deal of unquantified uncertainty in the EDT historical abundance estimates that should be taken into consideration when interpreting these data. In addition, the habitat scenarios evaluated as “historical” may not reflect historical distributions, since some areas are historically accessible but currently blocked by large dams are omitted from the analyses, and some areas that were historically inaccessible but recently passable because of human intervention are included. The EDT outputs are provided here to give a sense of the historical abundance of populations relative to each other and an estimate of the historical abundance relative to the current abundance.

Table A.2.5.5. Estimate of historical abundance based on EDT analysis by WDFW of equilibrium abundance under historical habitat conditions (Busack and Rawding 2003).

Population	EDT Estimate of Historical Abundance
Grays River fall-run	2,477
Coweeman River fall-run	4,971
Lower Cowlitz River fall--run	53,956
Toutle River fall-run	25,392
Kalama River fall-run	2,455
Lewis River fall-run (East Fork only)	4,220
Lewis River late fall-run (brights)	43,371
Washougal River fall-run	7,518
Upper Gorge Tributaries fall-run (Wind River only)	2,363
Toutle River spring-run	2,901
Kalama River spring-run	4,178

Loss of habitat from barriers—An analysis was conducted by Steel and Sheer (2003) to assess the number of stream km historically and currently available to salmon populations in the LCR (Table A.2.5.6). Stream km usable by salmon are determined based on simple gradient cut offs and on the presence of impassable barriers. This approach will over estimate the number of usable stream kilometers as it does not take into consideration habitat quality (other than gradient). However, the analysis does indicate that for some populations (particularly spring run) the number of stream habitat km currently accessible is greatly reduced from the historical condition.

Table A.2.5.6.. Loss of habitat from barriers. The potential current habitat is the kilometers of stream with a gradient between 0.5% and 4% below all currently impassable barriers. The potential historical habitat is the kilometers of stream with a gradient of between 0.5% and 4% below historically impassable barriers. The current to historical habitat ratio is the percent of the historical habitat that is currently available.

Population	Potential Current Habitat (km)	Potential Historical Habitat (km)	Current to Historical Habitat Ratio (%)
Youngs Bay fall-run	178	195	91
Grays River fall-run	133	133	100
Big Creek fall-run	92	129	71
Elochoman River fall-run	85	116	74
Clatskanie River fall-run	159	159	100
Mill, Abernathy, Germany Creeks fall-run	117	123	96
Scappoose Creek fall-run	122	157	78
Coweeman River fall-run	61	71	86
Lower Cowlitz River fall-run	418	919	45
Upper Cowlitz River fall-run			
Toutle River fall-run	217	313	69
Kalama River fall-run	78	83	94
Salmon Creek/Lewis River fall-run	438	598	73
Clackamas River fall-run	568	613	93

Washougal River fall-run	84	164	51
Sandy River fall-run	227	286	79
Lower Gorge Tributaries fall-run	34	35	99
Upper Gorge Tributaries fall-run	23	27	84
Hood River fall-run	35	35	100
Big White Salmon River fall-run	0	71	0
Sandy River late fall-run	217	225	96
North Fork Lewis River late fall-run (brights)	87	166	52
Upper Cowlitz spring-run	4	276	1
Cispus River spring-run	0	76	0
Tilton River spring-run	0	93	0
Toutle River spring-run	217	313	69
Kalama River spring-run	78	83	94
Lewis River spring-run	87	365	24
Sandy River spring-run	167	218	77
Big White Salmon River spring-run	0	232	0
Hood River spring-run	150	150	99
Total	4,075	6,421	63

A.2.5.4 New Hatchery Information

Recent Hatchery Releases

Updated information on chinook hatchery releases in the ESU is provided in Appendix A.5.3. These data indicate a high level of chinook hatchery production in the LCR. Categorizations of Lower Columbia River hatchery stocks (SSHAG 2003) can be found in Appendix A.5.1.

A.2.5.5 Comparison with Previous Data

ESU Summary

The ESU exhibits three major life history types: fall run (“tules”), late fall run (“brights”), and spring run. The ESU spans three ecological zones: Coastal (rain driven hydrograph), Western Cascade (snow or glacial driven hydrograph), and Gorge (transitioning to drier interior Columbia ecological zones). The fall chinook populations are currently dominated by large scale hatchery production, relatively high harvest and extensive habitat degradation (discussed in previous status reviews). The Lewis River late fall chinook population is the healthiest in the ESU and has a reasonable probability of being self-sustaining. The spring-run populations are largely extirpated as the result of dams which block access to their high elevation habitat. Abundances have largely declined since the last status review update (1998) and trend indicators for most populations are negative, especially if hatchery fish are assumed to have a reproductive success equivalent to that of natural-origin fish. However, 2001 abundance estimates increased for most LCR chinook populations over the previous few years and preliminary indications are that 2002 abundance also increased (Rawding, WDFW pers. com.). Many salmon populations in the Northwest have shown increases in abundance over the last few years and the relationship of

these increases to potential changes in marine survival are discussed in the introduction to this report.

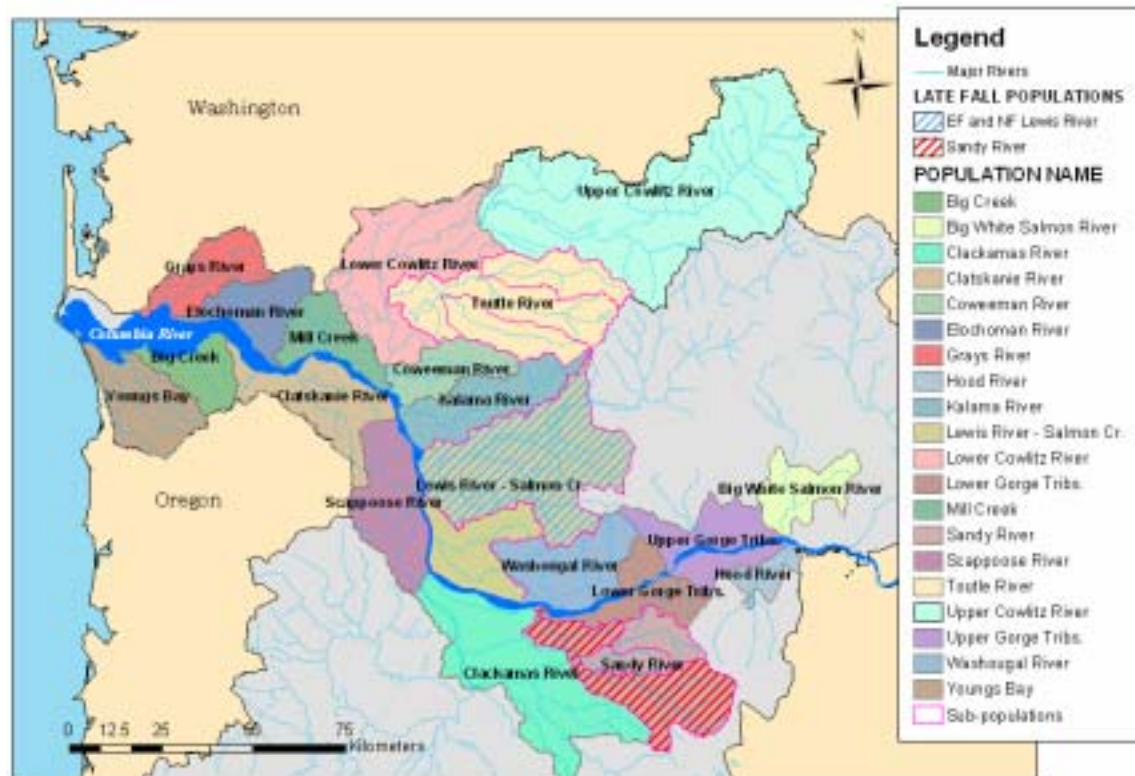


Figure A.2.5.1. Historical independent LCR early and late fall Chinook populations (Myers et al. 2002).



Figure A.2.5.2. Historical independent LCR spring Chinook populations (Myers et al. 2002).

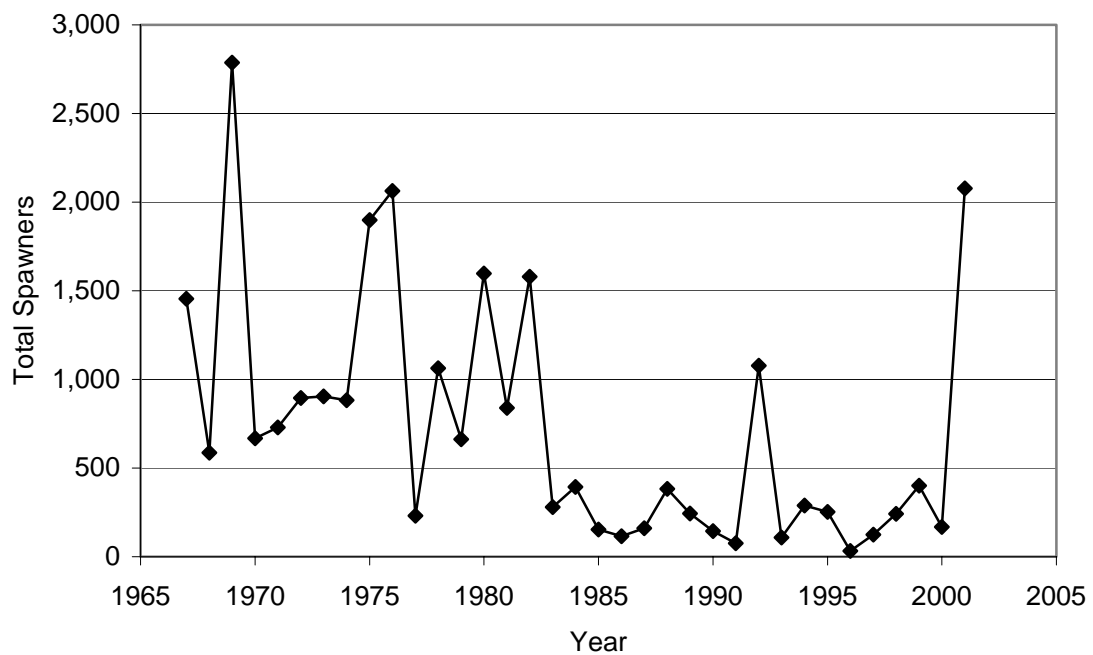


Figure A.2.5.3. Big White Salmon River fall-run chinook spawner abundance (hatchery and natural-origin).

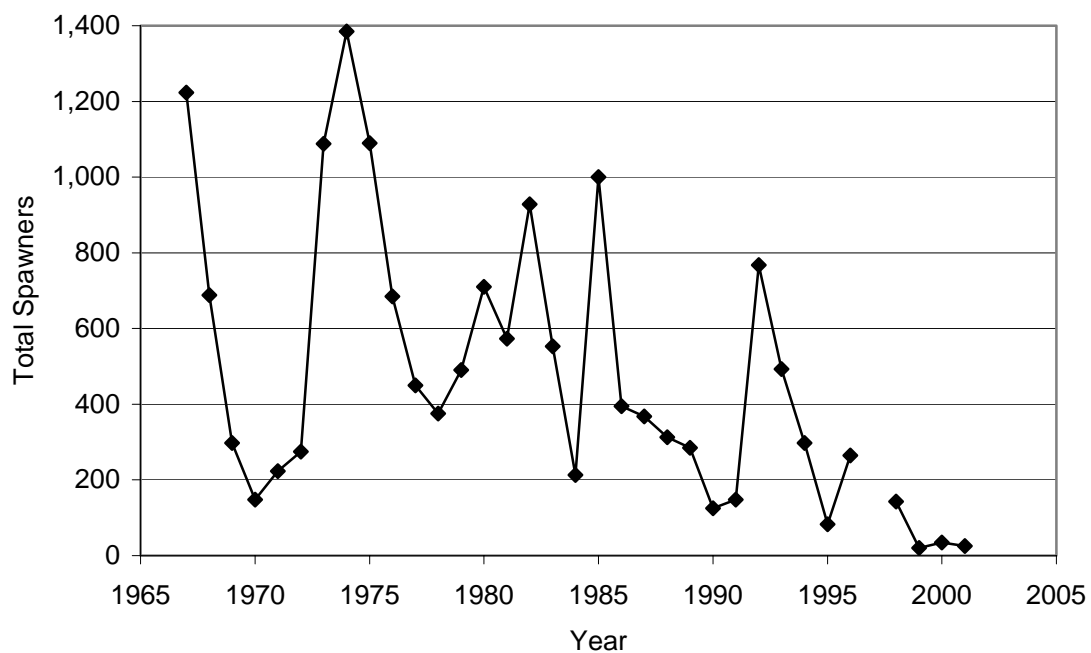


Figure A.2.5.4. Clackamas River fall-run chinook spawner abundance (hatchery and natural origin).

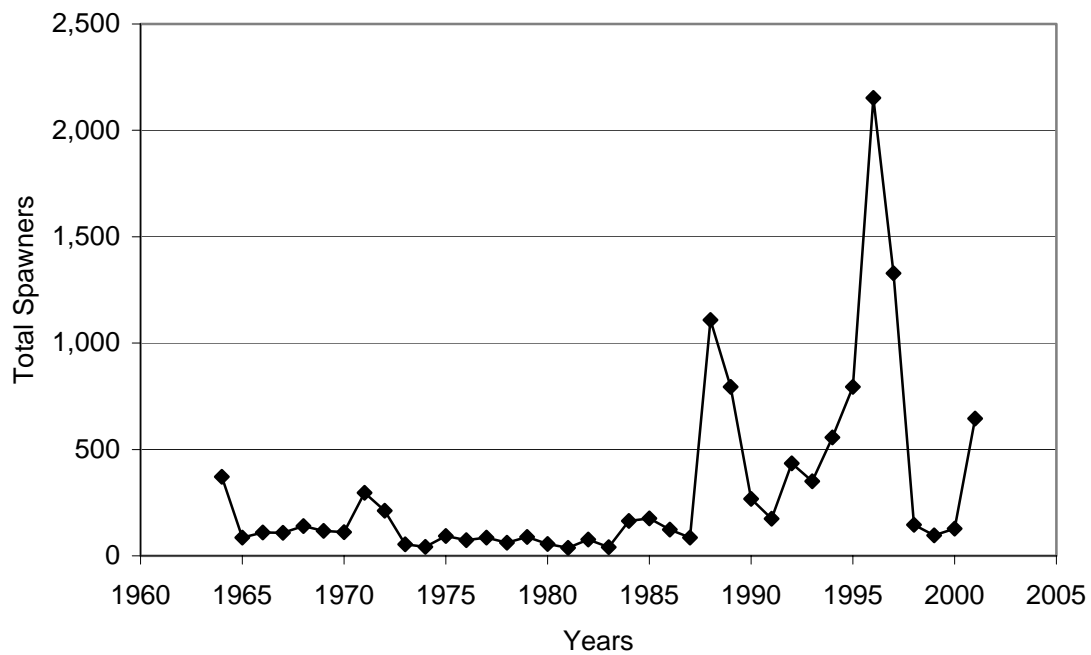


Figure A.2.5.5. Coweeman River fall-run chinook spawner abundance (almost all spawners are of natural origin).

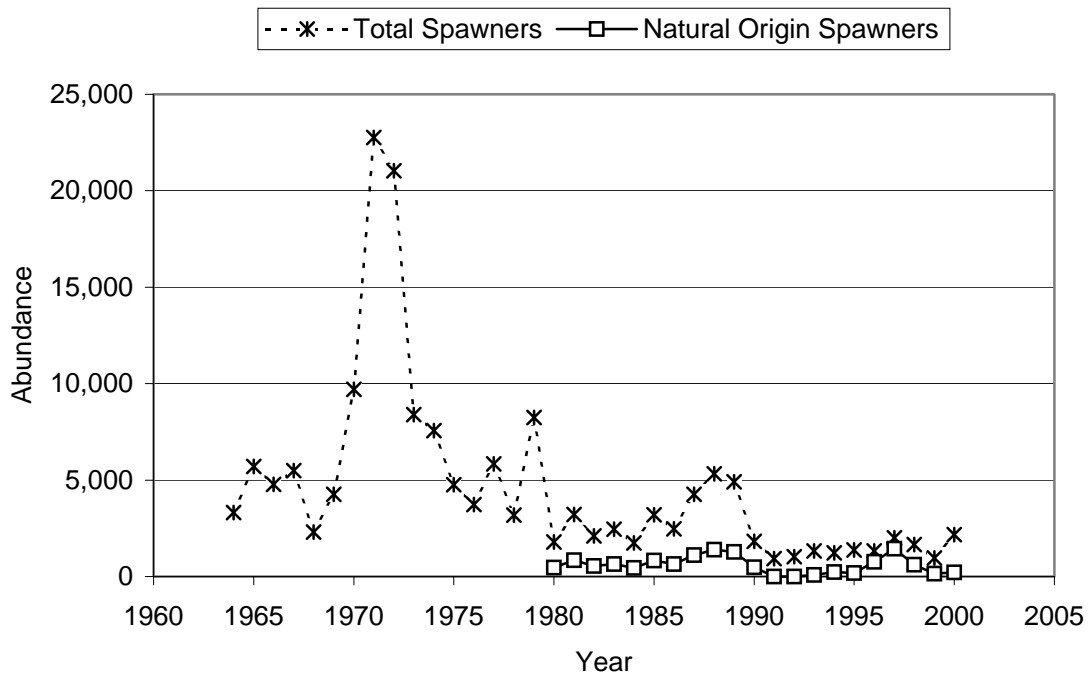


Figure A.2.5.6. Lower Cowlitz River fall-run chinook spawner abundance.

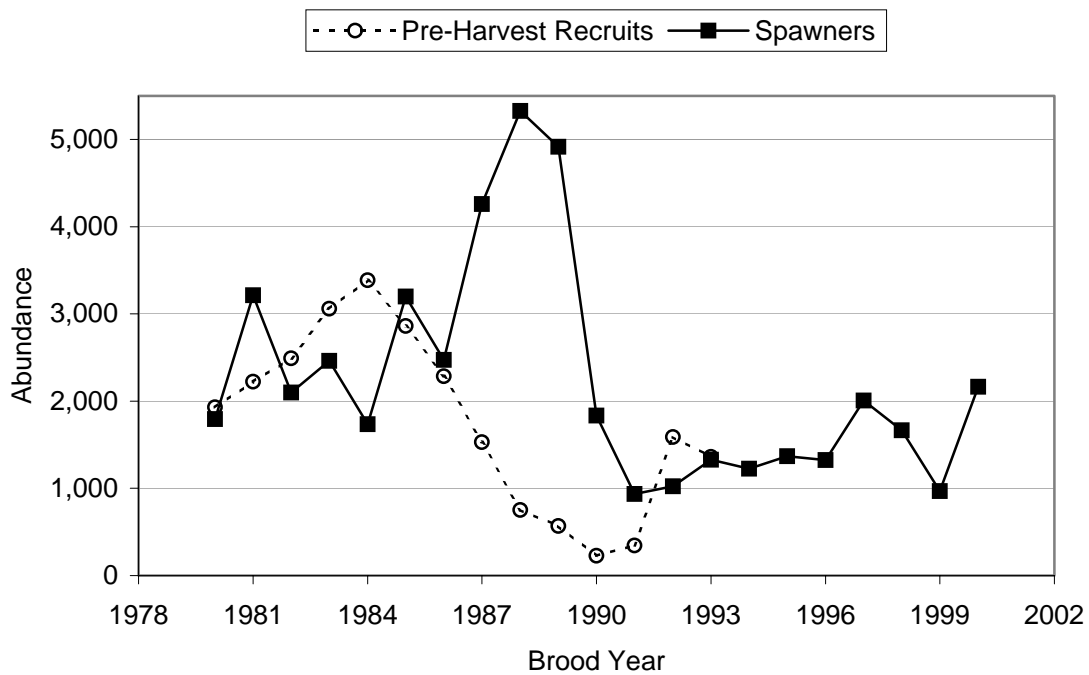


Figure A.2.5.7. Estimate of fall-run chinook pre-harvest recruits and spawners in the Cowlitz River.

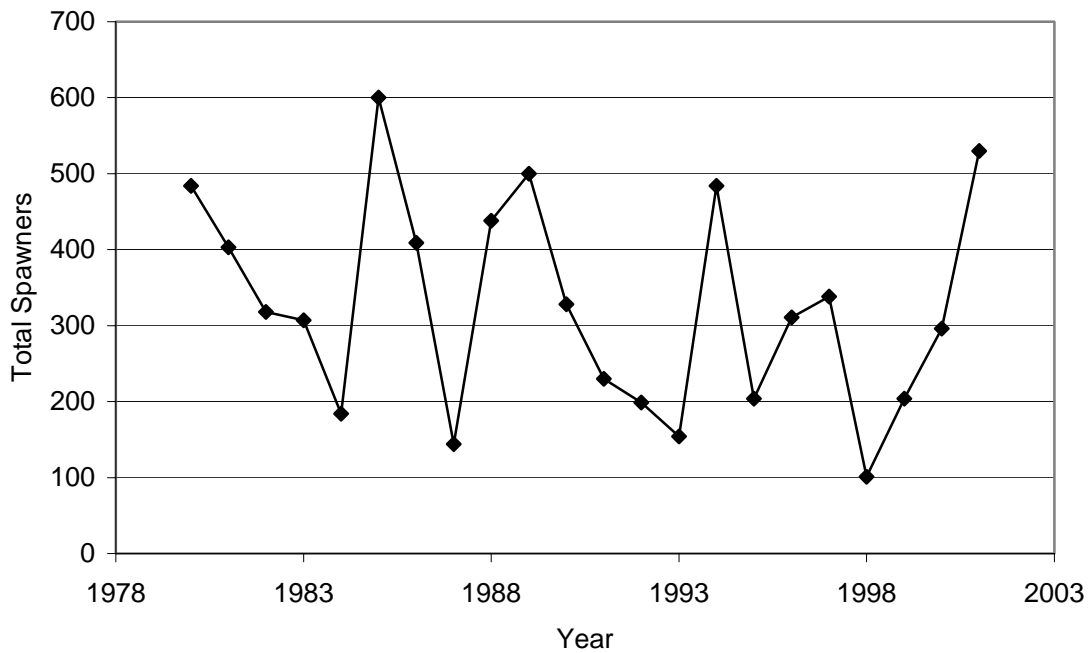


Figure A.2.5.8. East Fork Lewis River fall-run chinook total spawner abundance (almost all spawners are of natural origin).

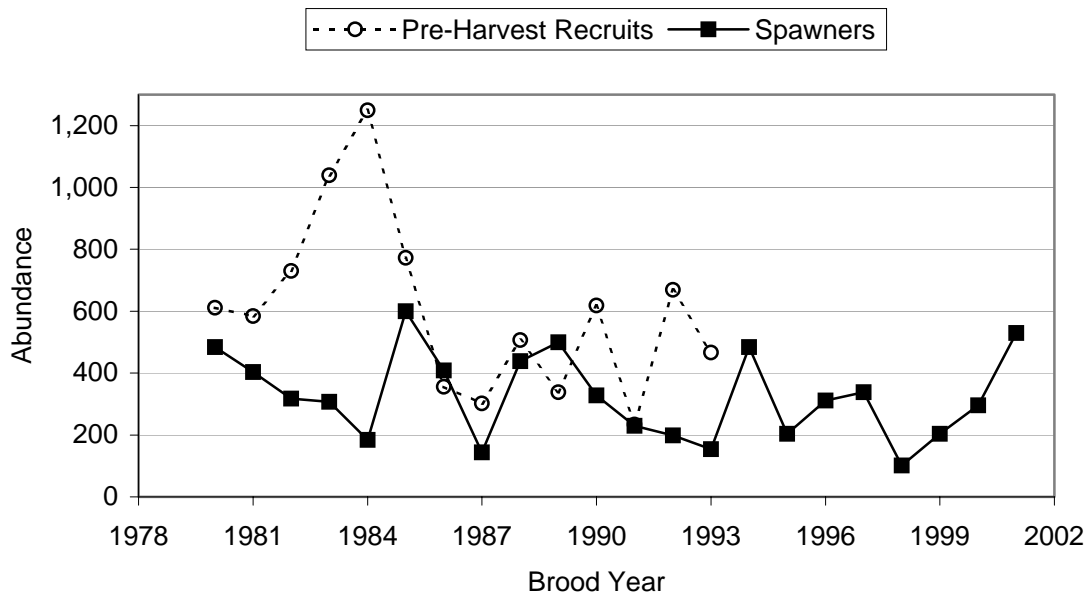


Figure A.2.5.9. Estimate of fall-run chinook preharvest recruits and spawners in the East Fork Lewis River.

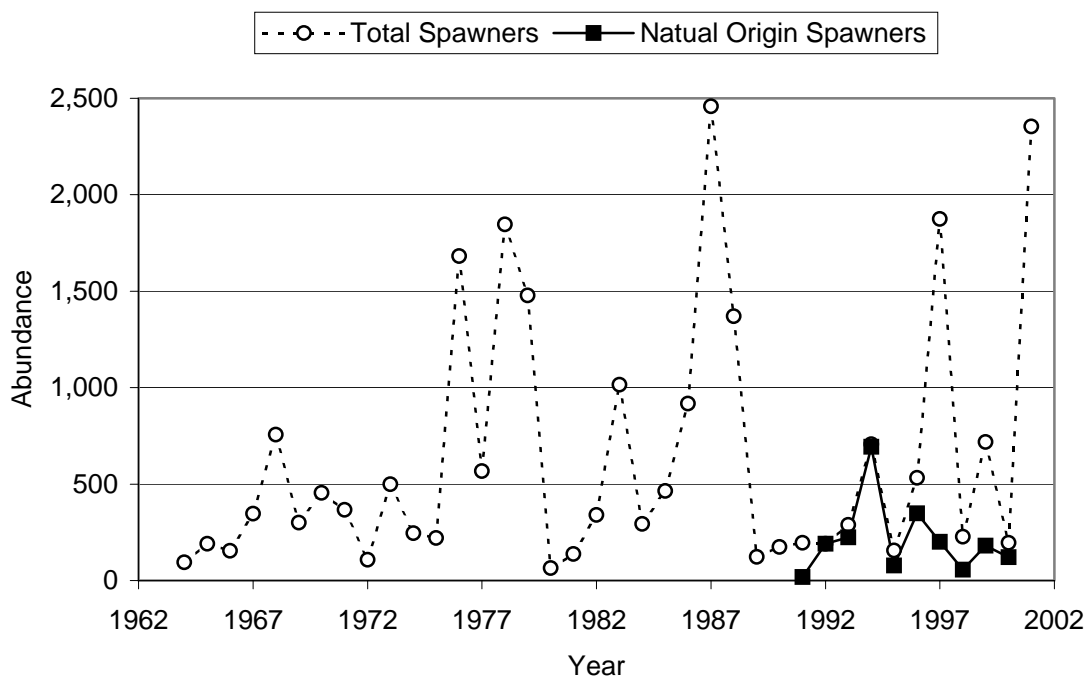


Figure A.2.5.10. Elochoman River fall-run chinook spawner abundance.

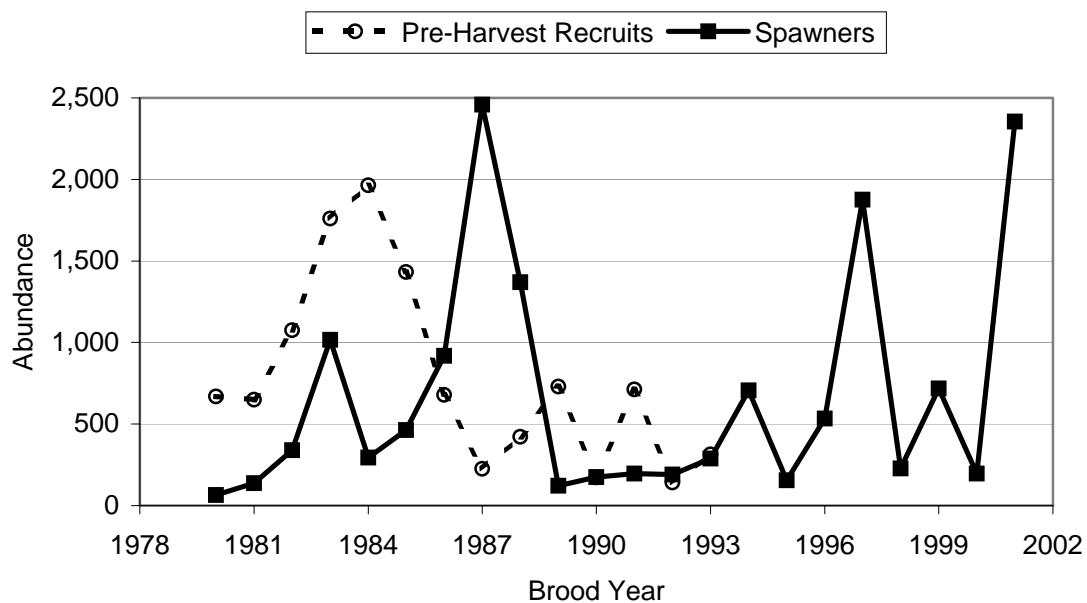


Figure A.2.5.11. Estimate of fall-run chinook pre-harvest recruits and spawners in the Elochoman River.

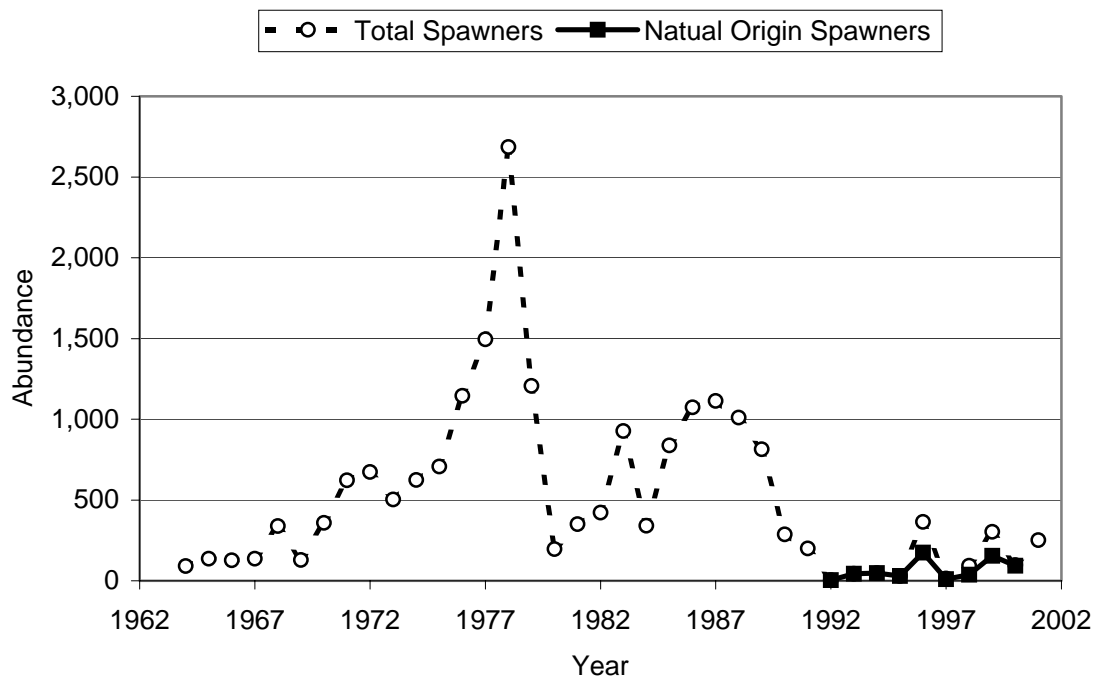


Figure A.2.5.12. Grays River fall-run chinook spawner abundance.

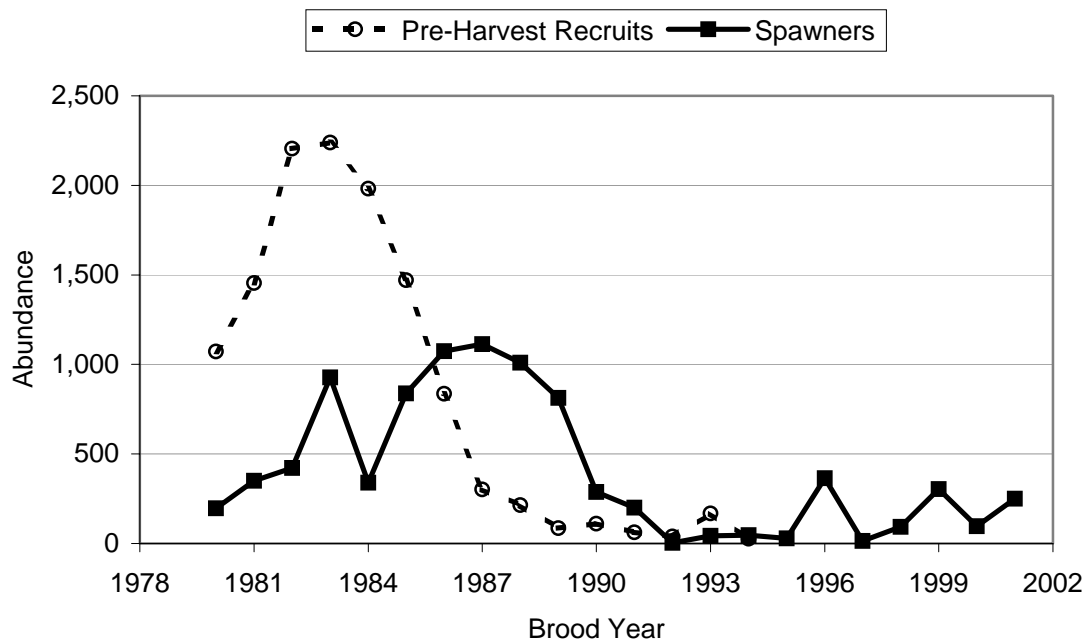


Figure A.2.5.13. Estimate of Grays River fall-run chinook pre-harvest recruits and spawners.

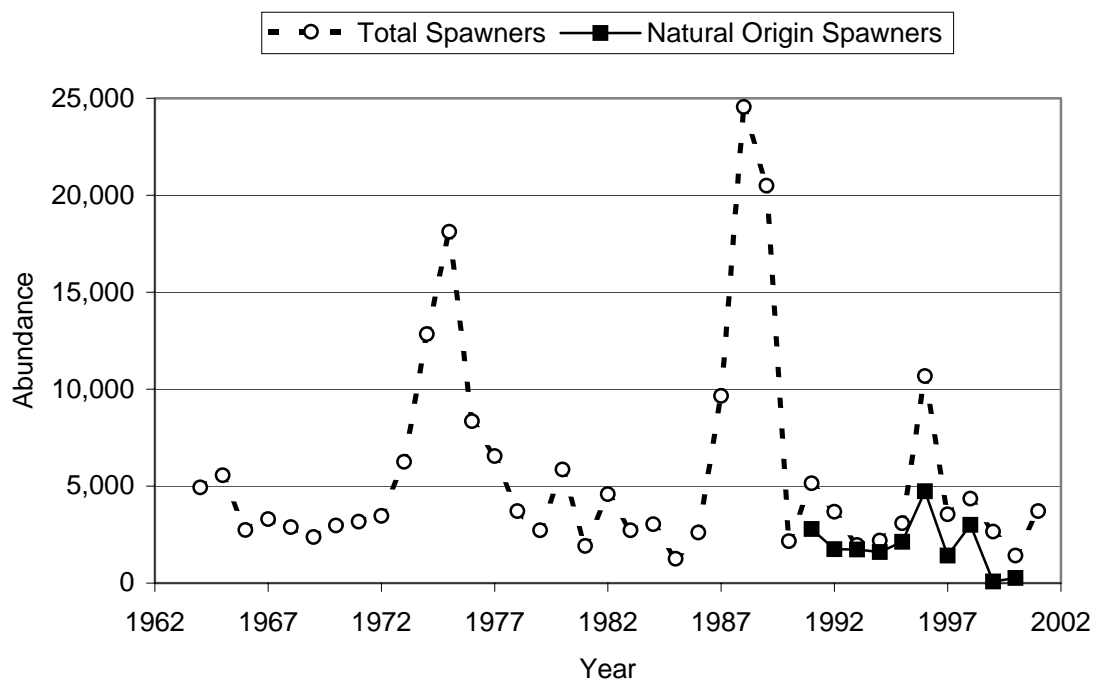


Figure A.2.5.14. Kalama River fall-run chinook spawner abundance.

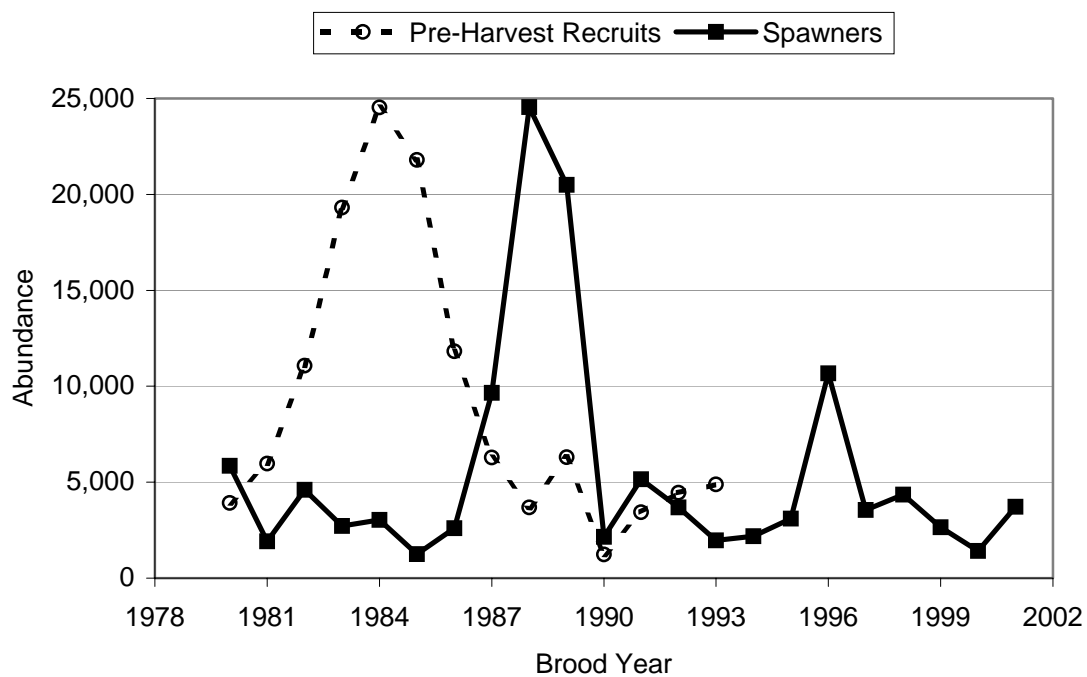


Figure A.2.5.15. Estimate of Kalama River fall-run chinook pre-harvest recruits and spawners.

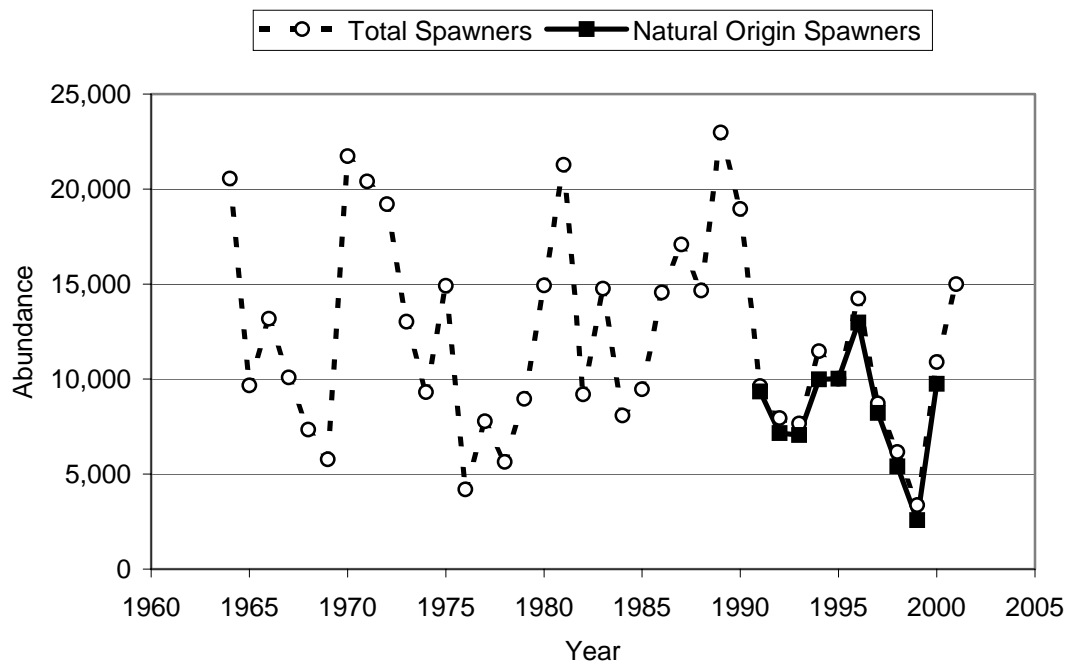


Figure A.2.5.16. Lewis River late fall-run (bright) chinook spawner abundance.

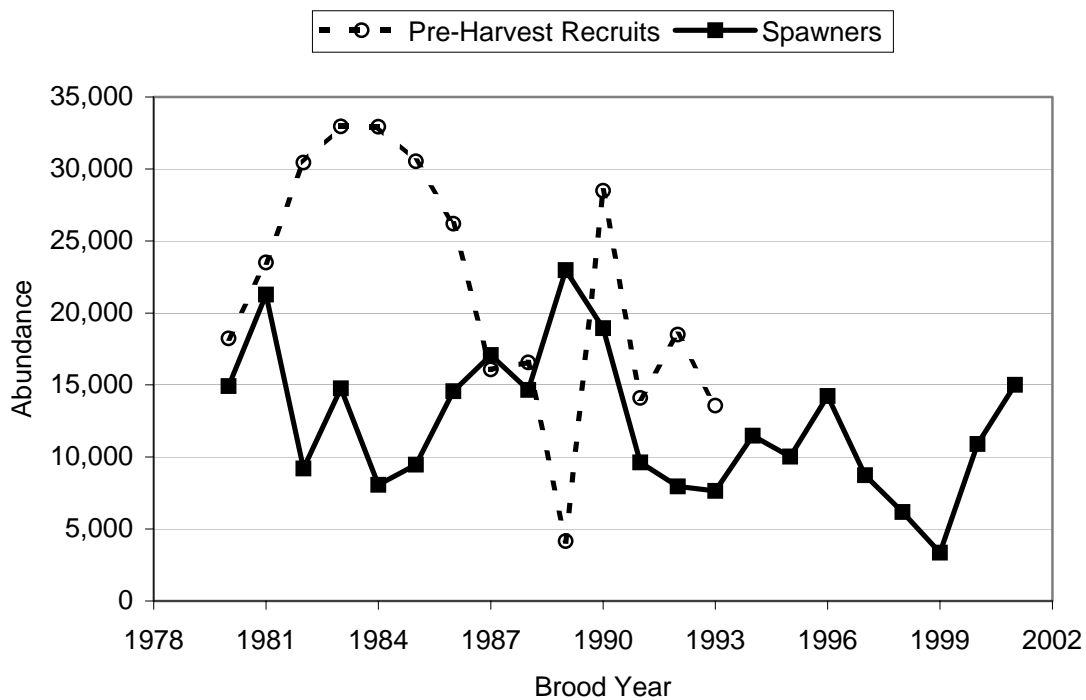


Figure A.2.5.17. Estimate of Lewis River late fall-run (bright) chinook pre-harvest recruits and spawners.

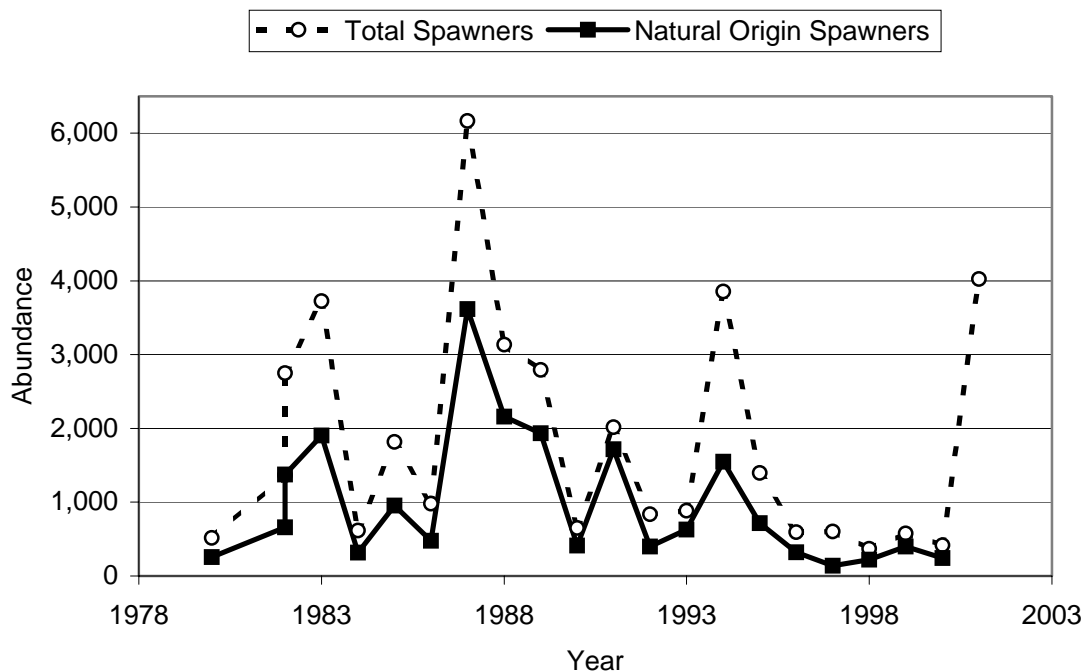


Figure A.2.5.18. Mill/Germany/Abernathy Creeks fall-run chinook spawner abundance.

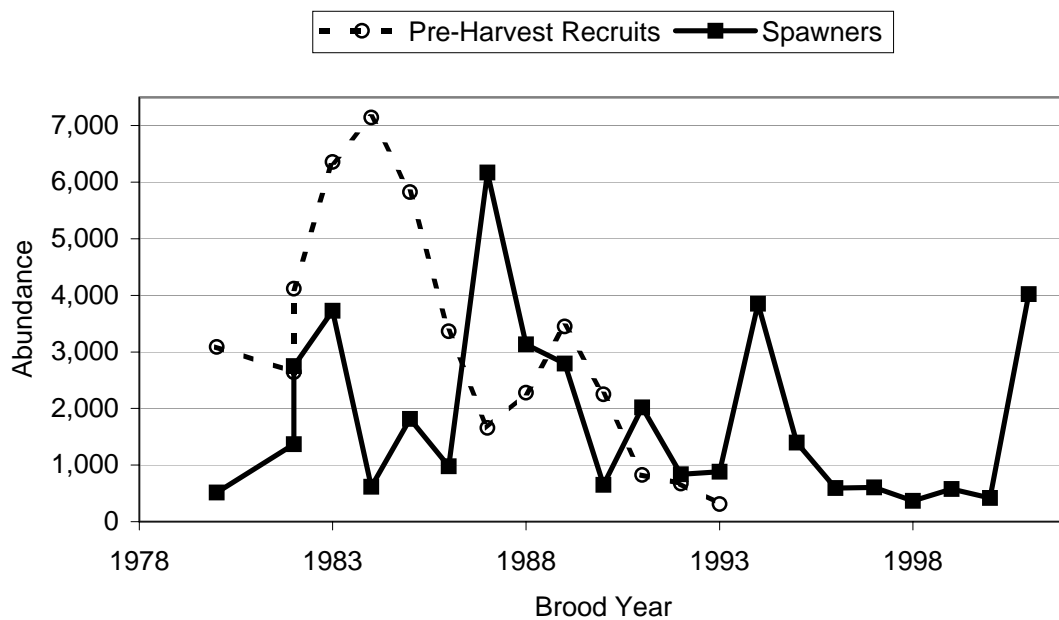


Figure A.2.5.19. Estimate of Mill/Germany/Abernathy Creeks fall-run chinook pre-harvest recruits and spawners.

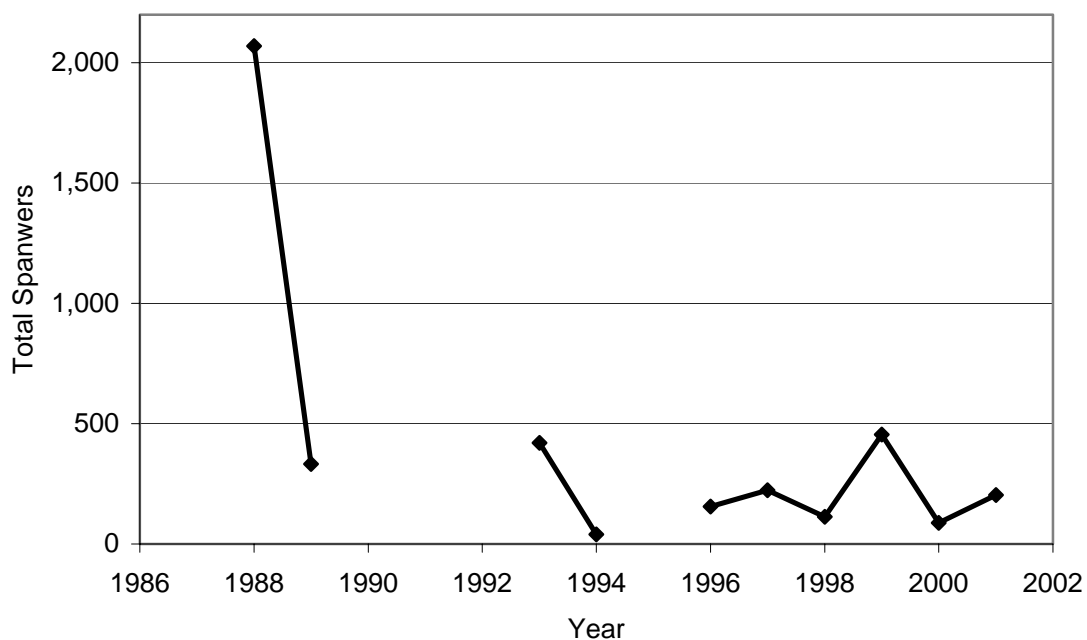


Figure A.2.5.20. Sandy River fall-run chinook spawner abundance.

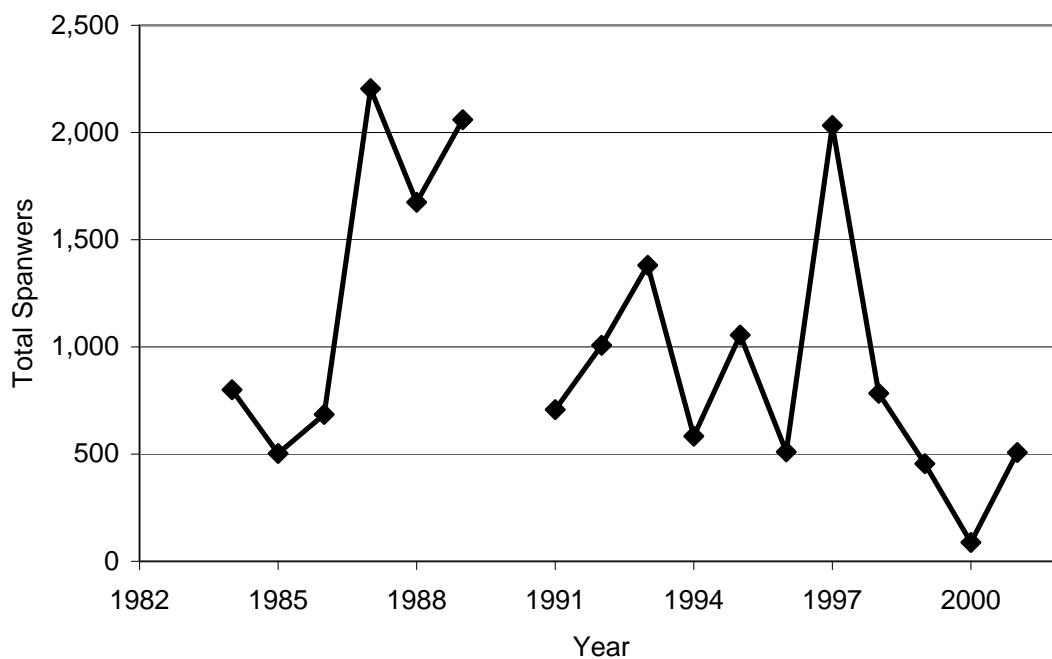


Figure A.2.5.21. Sandy River late fall-run (bright) chinook spawner abundance.

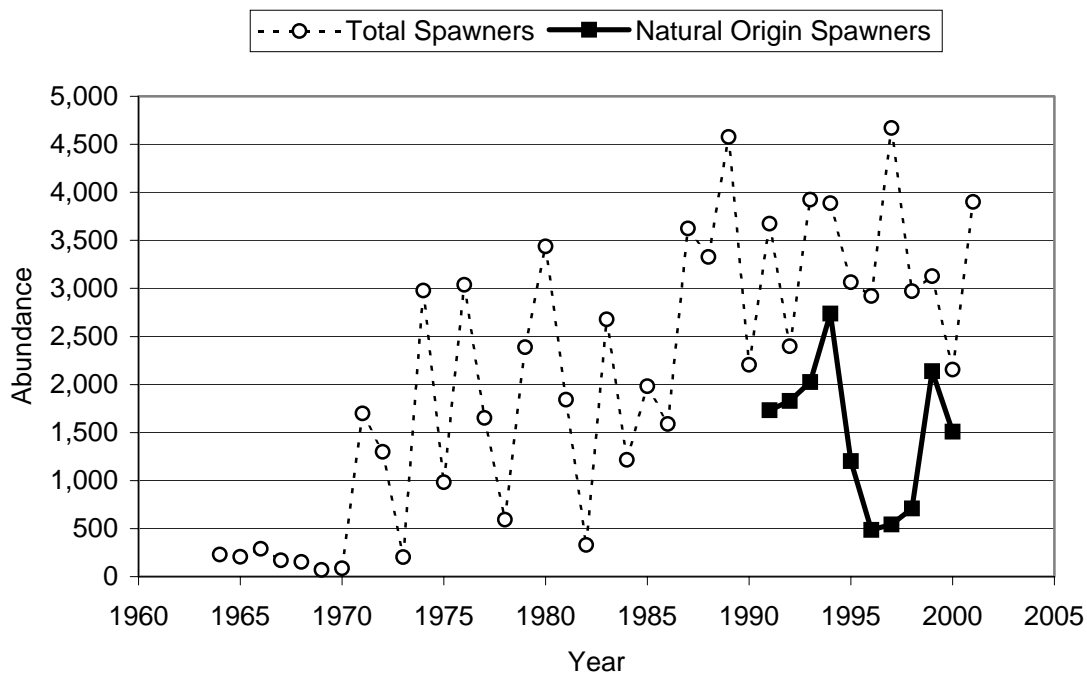


Figure A.2.5.22. Washougal River fall-run chinook spawner abundance.

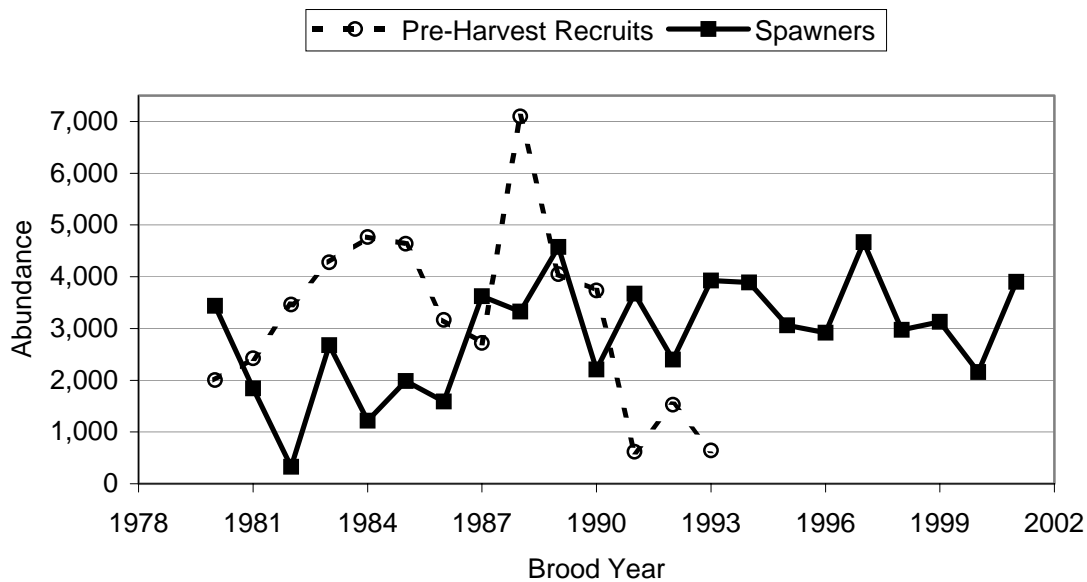


Figure A.2.5.23. Estimate of Washougal River fall-run chinook pre-harvest recruits and spawners.

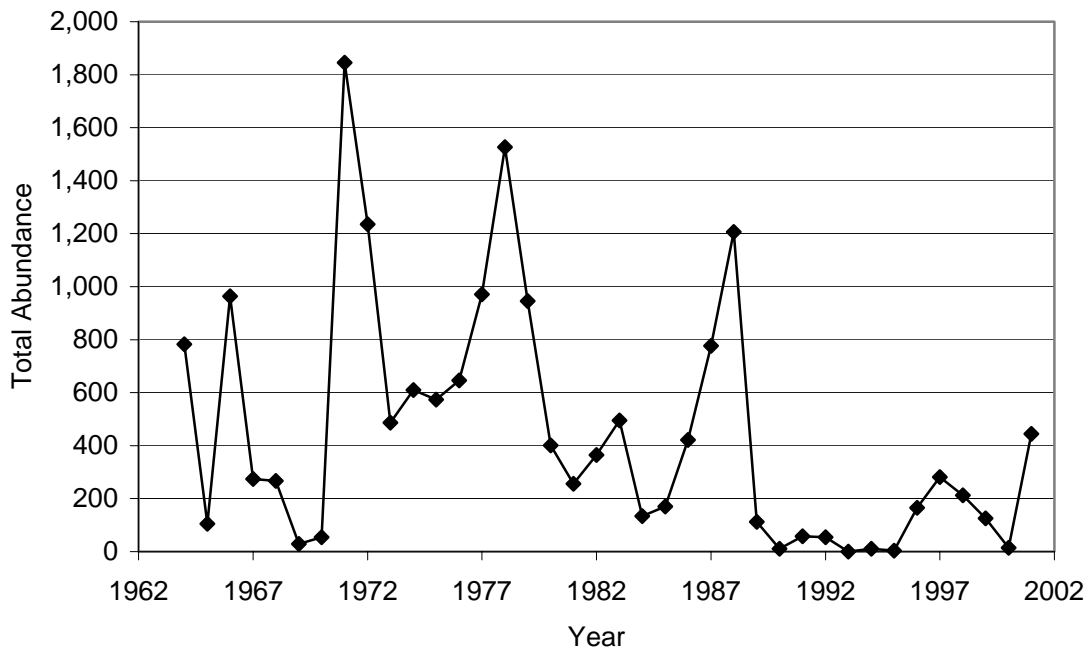


Figure A.2.5.24. Wind River fall-run chinook total spawner abundance (hatchery and natural origin).

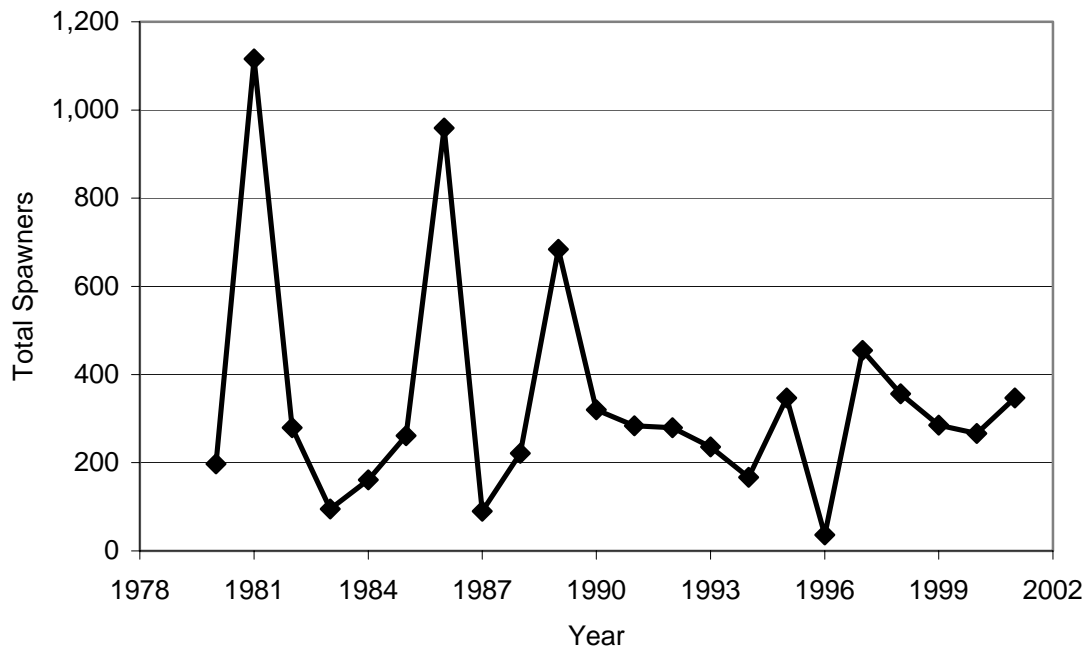


Figure A.2.5.25. Cowlitz River spring-run chinook total spawner abundance below Mayfield Dam (the majority of spawners are of hatchery origin).

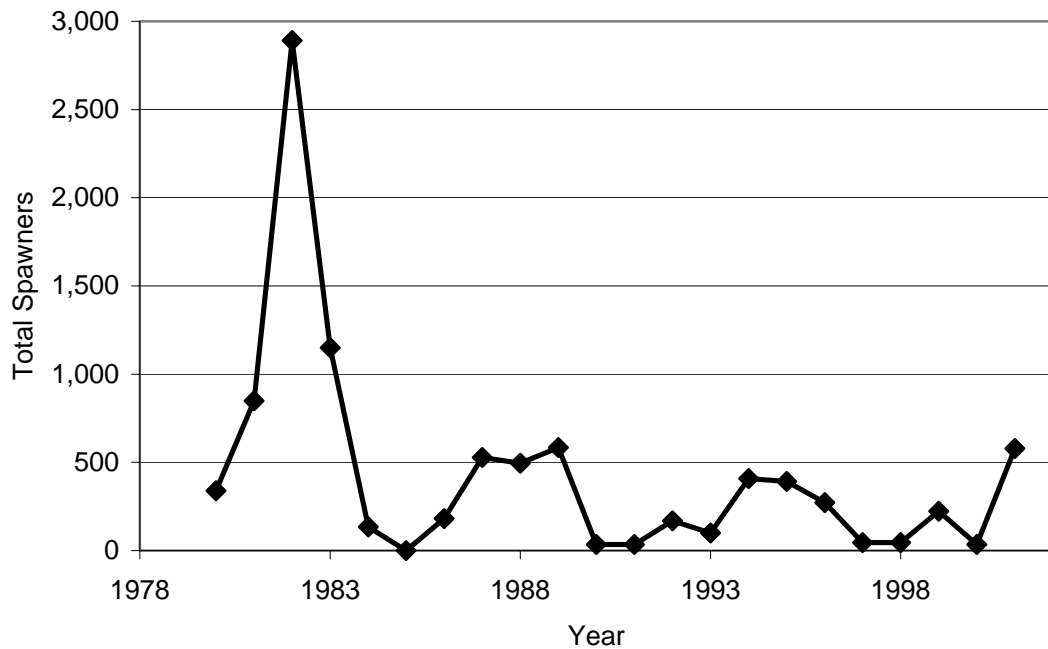


Figure A.2.5.26. Kalama River spring-run chinook total spawner (the majority of spawners are of hatchery origin).

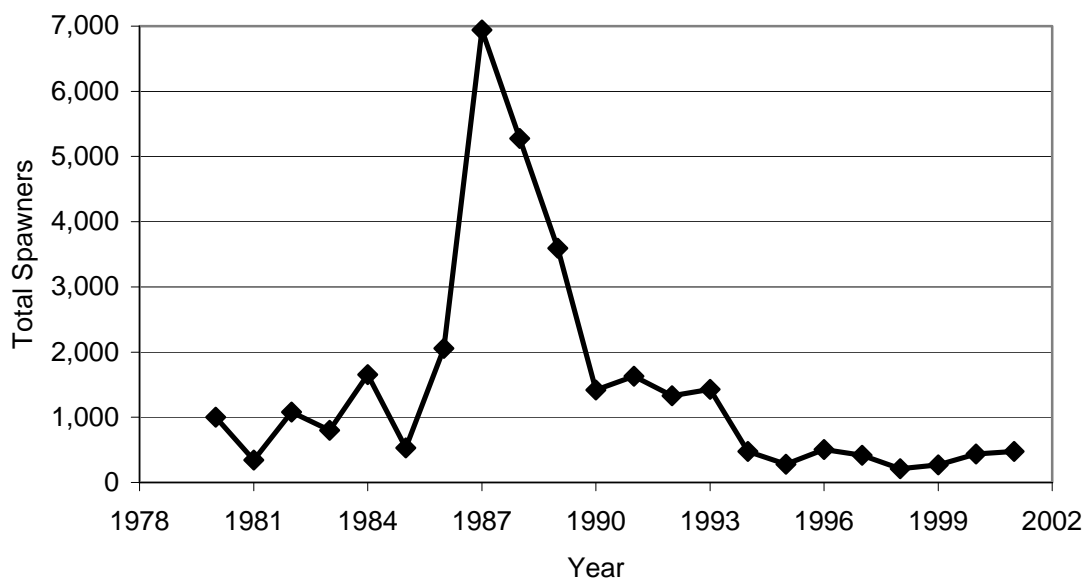


Figure A.2.5.27. Lewis River spring-run chinook total spawner abundance below Merwin Dam (the majority of spawners are of hatchery origin).

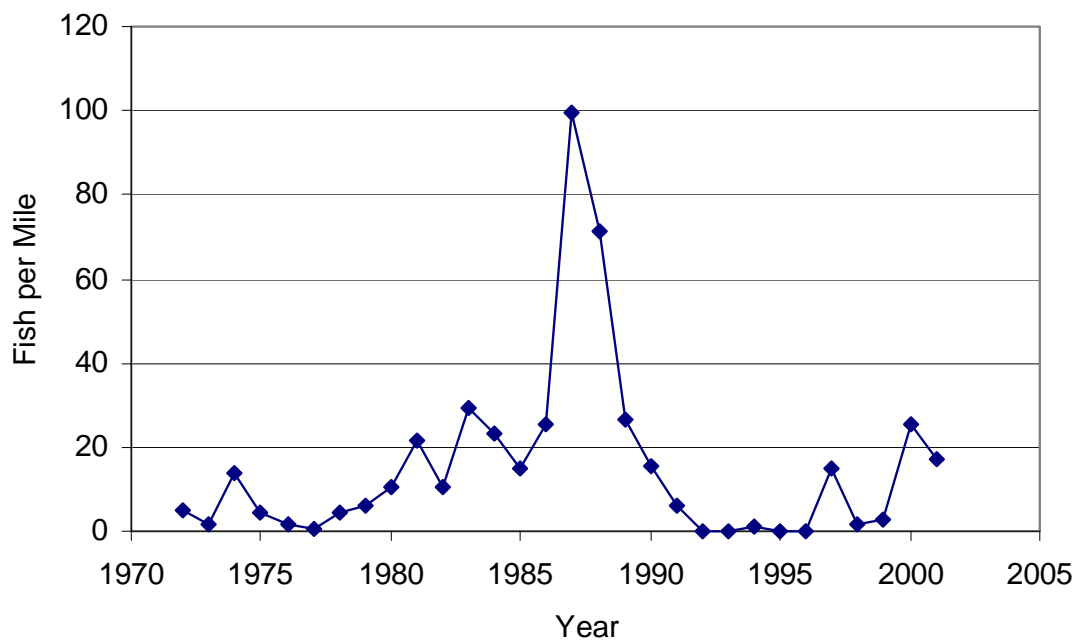


Figure A.2.5.28. Youngs Bay chinook fish-per-mile.

Big Creek Population

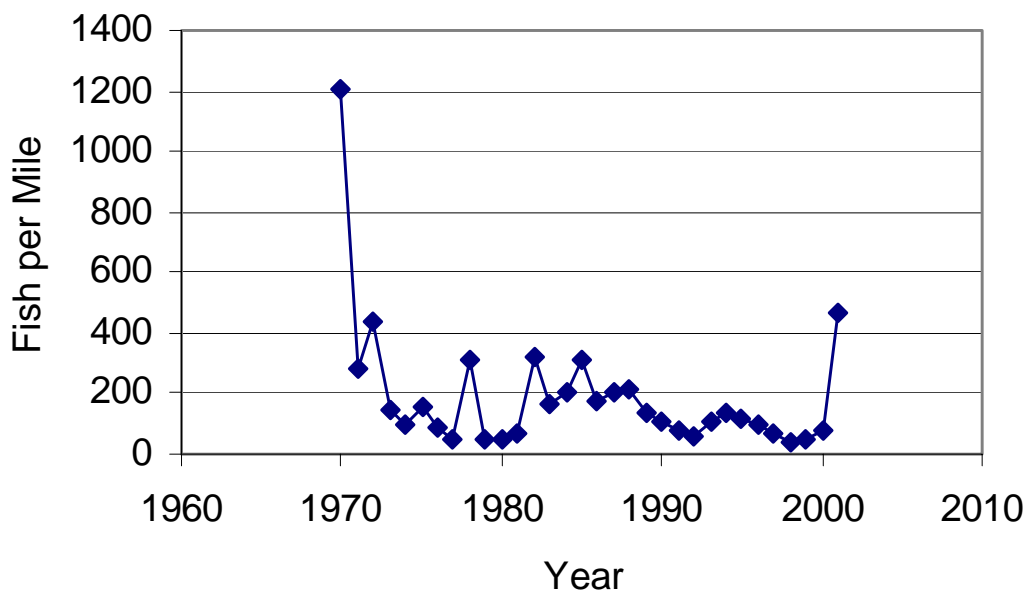


Figure A.2.5.29. Big Creek chinook fish-per-mile.

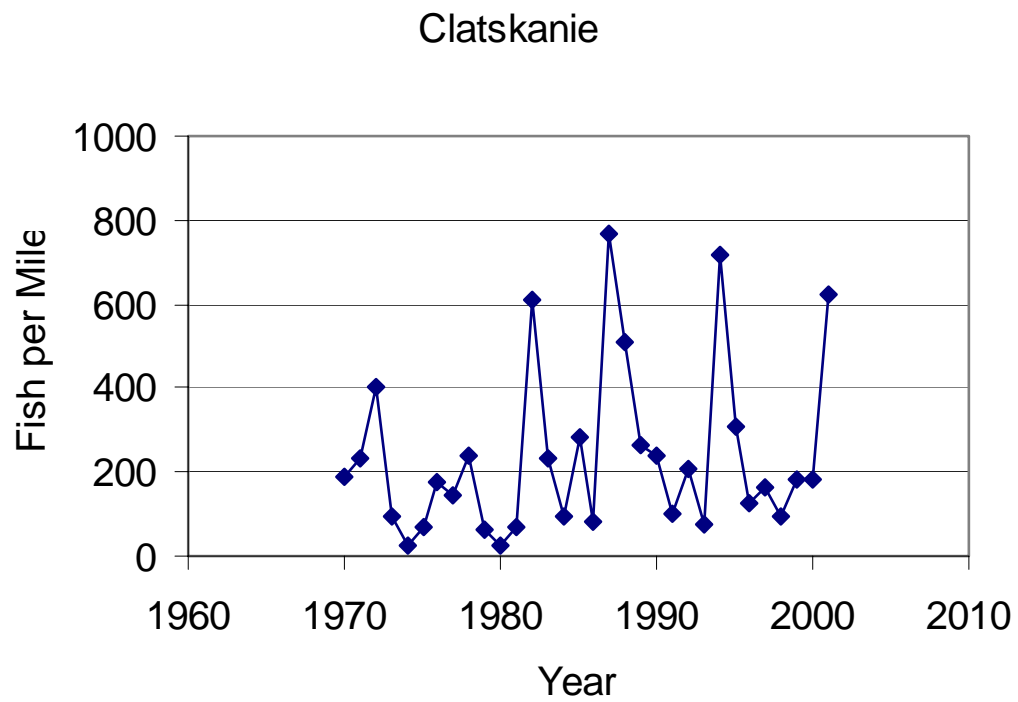


Figure A.2.5.30. Clatskanie River chinook fish-per-mile.

A.2.6 UPPER WILLAMETTE RIVER CHINOOK SALMON

A.2.6.1 Summary of Previous BRT Conclusions

The status of Upper Willamette River chinook was initially reviewed by NMFS in 1998 (Myers et al. 1998) and updated in that same year (NMFS 1998). In the 1998 update, the BRT noted several concerns for this ESU. The previous BRT was concerned about the few remaining populations of spring chinook salmon in the Upper Willamette River ESU, and the high proportion of hatchery fish in the remaining runs. The BRT noted with concern that ODFW was able to identify only one remaining naturally-reproducing population in this ESU—the spring chinook salmon in the McKenzie River. The previous BRT was concerned about severe declines in short-term abundance that occurred throughout the ESU, and the McKenzie River population had declined precipitously, indicating that it may not be self-sustaining. The 1998 BRT also noted the potential for interactions between native spring-run and introduced fall-run chinook salmon had increased relative to historical times due to fall-run chinook salmon hatchery programs and the laddering of Willamette Falls. The previous BRT partially attributed the declines in spring chinook salmon in the Upper Willamette River ESU to the extensive habitat blockages caused by dam construction. The previous BRT was encouraged by efforts to reduce harvest pressure on naturally-produced spring chinook salmon in Upper Willamette River tributaries, and the increased focus on selective marking of hatchery fish should help managers targeting specific populations of wild or hatchery chinook salmon. A majority of the previous (1998) BRT concluded that the Lower Columbia River ESU was likely to become endangered in the foreseeable future. A minority felt that chinook salmon in this ESU were not presently in danger of extinction, nor were they likely to become so in the foreseeable future.

Current Listing Status: threatened

A.2.6.2 New Data and Updated Analyses

New data for this update include spawner abundance through 2002 in Clackamas, 2001 in McKenzie and 2001 at Willamette Falls. In addition, new data include updated redd surveys in the basin, new estimates of the fraction of hatchery-origin spawners in McKenzie and North Santiam from an otolith marking study, the first estimate of hatchery fraction in the Clackamas (2002 data), and information on recent hatchery releases. New analyses for this update include: the designation of relatively demographically independent populations, recalculation of previous BRT metrics in the McKenzie with additional years of data, estimates of current and historically available kilometers of stream, and updates on current hatchery releases.

Historical population structure—As part of its effort to develop viability criteria for UW chinook, the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Myers et al. (2002) hypothesized that the ESU historically consisted of 7 spring run populations (Figure A.2.6.1). The populations identified in Myers et al. (2002) are used as the units for the new analyses in this report.

Abundance and trends

References for abundance time series and related data are in Appendix A.5.3. Recent abundance of natural-origin spawners, recent fraction of hatchery-origin spawners, and recent harvest rates for UW Chinook populations are summarized in Table A.2.6.1. The total number of spring chinook spawners passing Willamette Falls from 1953 to 2001 is shown in Figure A.2.6.2. All spring chinook in the ESU, except those entering the Clackamas River, must pass Willamette Falls. There is no assessment of the ratio of hatchery-origin to natural-origin chinook passing the falls, but the majority of fish are undoubtedly of hatchery origin. (Natural-origin fish are defined as having had parents that spawned in the wild as opposed to hatchery -origin fish whose parents spawned in a hatchery.) The status of individual populations is discussed below.

Clackamas—The count of spring chinook passing the North Fork dam on the Clackamas from 1958 to 2002 are shown in Figure A.2.6.3 (Cramer 2002). The total number of chinook passing above the dam has exceeded 1,000 in most years since 1980 and the last several year show large increases. However, the majority of these fish are likely of hatchery origin. The only year for which hatchery-origin estimates are available is 2002 and the estimate is 64% of hatchery origin. Although the majority of spring chinook spawning habitat is above North Fork Dam, spawning is observed below the dam. The majority of spawning below the dam is also considered to be by hatchery-origin spawners. The population has shown substantial increases in total abundance (mixed hatchery and natural origin) in the last couple of years.

Molalla—A 2002 survey of 16.3 miles of stream in the Molalla found 52 redds. However, 93% of the carcasses recovered in the Molalla in 2002 were fin-clipped and of hatchery origin (Schroeder et al 2002). Fin-clip recovery fractions for spring chinook in the Willamette tend to underestimate the proportion of hatchery-origin spawners (Schroeder et al. 2002), so the true fraction is likely in excess of 93 % (i.e. near 100%). The Molalla natural spring chinook population is believed to be extirpated, or nearly so.

North Santiam—Survey estimates of redds per mile in the North Santiam are shown in Figure A.2.6.4 (from Schroeder et al 2002). The number of stream miles surveyed varies between 26.8 and 43.5. The total redds counted in a year varies between 116 and 310. Schroeder et al. (2002) estimate an escapement of 94 natural-origin spawners above Bennett Dam in 2000 and 151 in 2001. These natural-origin spawners were greatly outnumbered by hatchery-origin spawners (2,192 and 6,635 in 2000 and 2001 respectively). This resulted in estimated 94% hatchery-origin spawners in 2000 and 98% in 2001. This population is not considered self-sustaining.

South Santiam—A 2002 survey of 50.8 miles of stream in the South Santiam River below Foster dam found 982 redds. However, 84% of the carcasses recovered in the South Santiam in 2002 were fin-clipped and of hatchery origin (Schroeder et al 2002). Fin-clip recovery fractions for spring chinook in the Willamette tend to underestimate the proportion of hatchery-origin spawners (Schroeder et al 2002), so the true fraction is likely in excess of 84 %. This population is not considered self-sustaining.

Calapooia—A 2002 survey of 11.1 miles of stream in the Calapooia above Brownsville found 16 redds (Schroeder et al 2002). The carcasses recovered in the Calapooia in 2002 were too

decomposed to determine the presence or absence of fin clips. However, it was assumed that all the fish were surplus hatchery fish outplanted from the South Santiam hatchery (Schroeder et al. 2002). The Calapooia natural spring chinook population is believed to be extirpated, or nearly so.

McKenzie—The time series of total spring chinook counts and natural-origin fish passing Leaburg Dam on the McKenzie is shown in Figure A.2.6.5. The average fraction of hatchery-origin fish passed above the dam from 1998 to 2001 was estimated at 26%. Redds are observed below Leaburg Dam, but the fraction of hatchery-origin fish is higher (Schroeder et al 2002). The fraction of fin-clipped spring chinook carcasses recovered below Leaburg was 72% in 2000 and 67% in 2001. Again, fin clip recoveries tend to underestimate the fraction of hatchery-origin spawners. The spring chinook population above Leaburg Dam in the McKenzie is considered the best in the ESU, but with over 20% of the fish of hatchery origin, it is difficult to determine if this population would be naturally self-sustaining. The population has shown substantial increases in total abundance (mixed hatchery and natural origin) in the last couple of years.

Middle Fork Willamette—A 2002 survey of 17 miles of the mainstem Middle Fork found 64 redds. However, 77% of the carcasses recovered in the Middle Fork in 2002 were fin-clipped and of hatchery origin (Schroeder et al 2002). In Fall Creek, a tributary of the Middle Fork, 171 redds in 13.3 miles were found in 2002. The 2002 carcass survey found 39% of fish fin-clipped. Fin-clip recovery fractions for spring chinook in the Willamette tend to underestimate the proportion of hatchery-origin spawners. This population is not considered self-sustaining.

No formal trend analyses were conducted on any of the UW chinook populations. The two populations with long time series of abundance (Clackamas and McKenzie) have insufficient information on the fraction of hatchery-origin spawners to permit a meaningful analysis.

Loss of habitat from barriers—An analysis was conducted by Steel and Sheer (2002) to assess the number of stream km historically and currently available to salmon populations in the UW (Table A.2.6.1). Stream km usable by salmon are determined based on simple gradient cut offs and on the presence of impassable barriers. This approach will overestimate the number of usable stream km, as it does not take into consideration habitat quality (other than gradient). However, the analysis does indicate that for some populations the number of stream habitat km currently accessible is significantly reduced from the historical condition.

Table A.2.6.1. Historical populations of Upper Willamette spring-run chinook salmon. For the McKenzie River population, hatchery fraction is the average percent of spawners of hatchery origin over the last four years. For the Clackamas River population, only one year of hatchery fraction estimate is available (2002). Hatchery fraction in the Molalla, South Santiam and Middle Fork are minimum estimates based on the ratio of adipose marked verses unmarked fish recovered in 2001 (Schroeder et al. 2002). The current and historical habitat estimates are based on analysis by Steel and Sheer (2002).

Population	Hatchery Fraction (%)	Potential Current Habitat (%)	Potential Historical Habitat (km)	Current to Historical Habitat Ratio (%)
Clackamas River	64	369	475	78
Molalla River	>93	432	688	63
North Santiam River	97	173	269	64
South Santiam River	>84	445	658	68
Calapooia River	Estimated @ 100%	163	253	65
McKenzie River	26	283	382	74
Middle Fork Willamette River	>77	197	425	46
Total		2,063	3,150	65

Hatchery releases

A large number of spring chinook are released in the Upper Willamette as mitigation for the loss of habitat above federal hydroprojects (Table A.2.6.2). This hatchery production is considered a potential risk, because it masks the productivity of the natural population, interbreeding of hatchery and natural fish poses potential genetic risks and the incidental take from the fishery promoted by the hatchery production can increase adult mortality. Harvest retention is only allowed for hatchery marked fish, but take from hooking mortality and non-compliance is still a potential issue.

Fall chinook are not native to the upper Willamette and are not part of the Upper Willamette chinook ESU. Fall chinook hatchery fish are no longer released into the upper Willamette, though there have been substantial releases in the past (Figure A.2.6.6).

A.2.6.3 ESU Summary

The updated information provided in this report, the information contained in previous UW chinook status reviews, and preliminary analysis by the WLC-TRT, indicate that most natural spring chinook populations are likely extirpated or nearly so. The only population considered potentially self-sustaining is the McKenzie. However, its abundance has been relatively low (low thousands) with a substantial number of these fish being of hatchery origin. The population has shown a substantial increase in the last couple of years, hypothesized to be a result of increase ocean survival. It is unknown what ocean survivals will be in the future and the long-term sustainability of this population is uncertain.

Table A.2.6.2. Upper Willamette spring-run chinook hatchery releases (compiled by Waknitz 2002).

Watershed	Years	Hatchery	Stock	Release Site	Total
Willamette R	1994	Dexter Pd	McKenzie	L Willamette R	73,028
	1995	Dexter Pd	Willamette	L Willamette R	137,573
	1995	Lone Star	Clackamas	L Willamette R	59,654
	1995	Marion Forks	N Santiam	L Willamette R	40,320
	1993, 1994	McKenzie	McKenzie	L Willamette R	344,089
	1992, 1993	Step	Clackamas	L Willamette R	70,193
	1993, 1994	Step	McKenzie	L Willamette R	331,446
	1993-1995	McKenzie	Clackamas	L Willamette R	125,585
	1996-1999	Willamette	McKenzie	L Willamette R	225,122
	1995-1996	Willamette	N Santiam	L Willamette R	81,513
	1995-1999	McKenzie	McKenzie	L Willamette R	574,117
Clackamas R	1991-1994	Clackamas	Clackamas	Clackamas R	4,358,092
	1995-2002	Clackamas	Clackamas	Clackamas R	9,182,916
	1996-2001	McKenzie	McKenzie	Clackamas R	1,332,542
	1991	Eagle Creek NFH	Clackamas	Eagle Cr	556,814

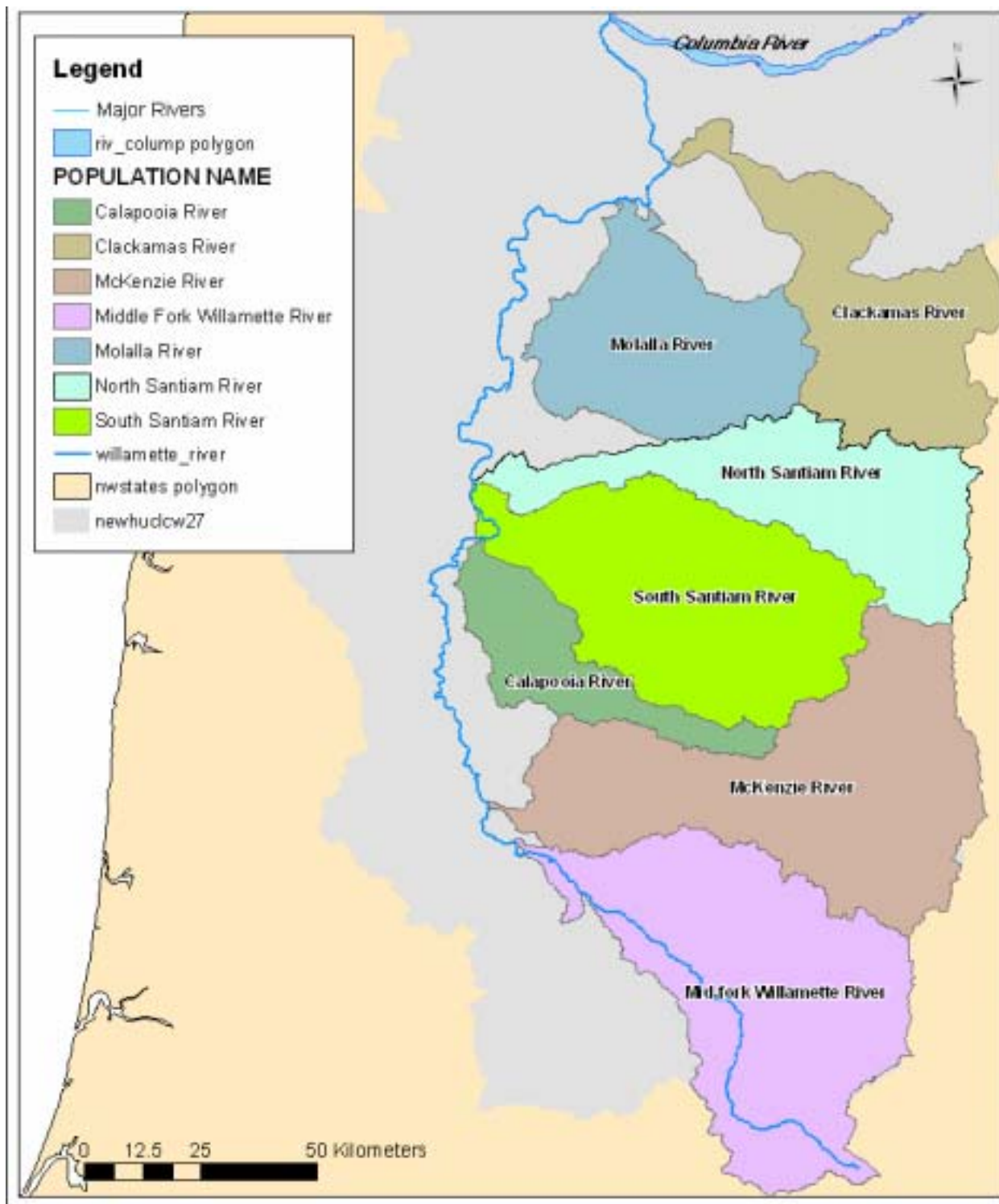


Figure A.2.6.1. Historical populations of spring-run chinook in the Willamette ESU (Myers et al. 2002).

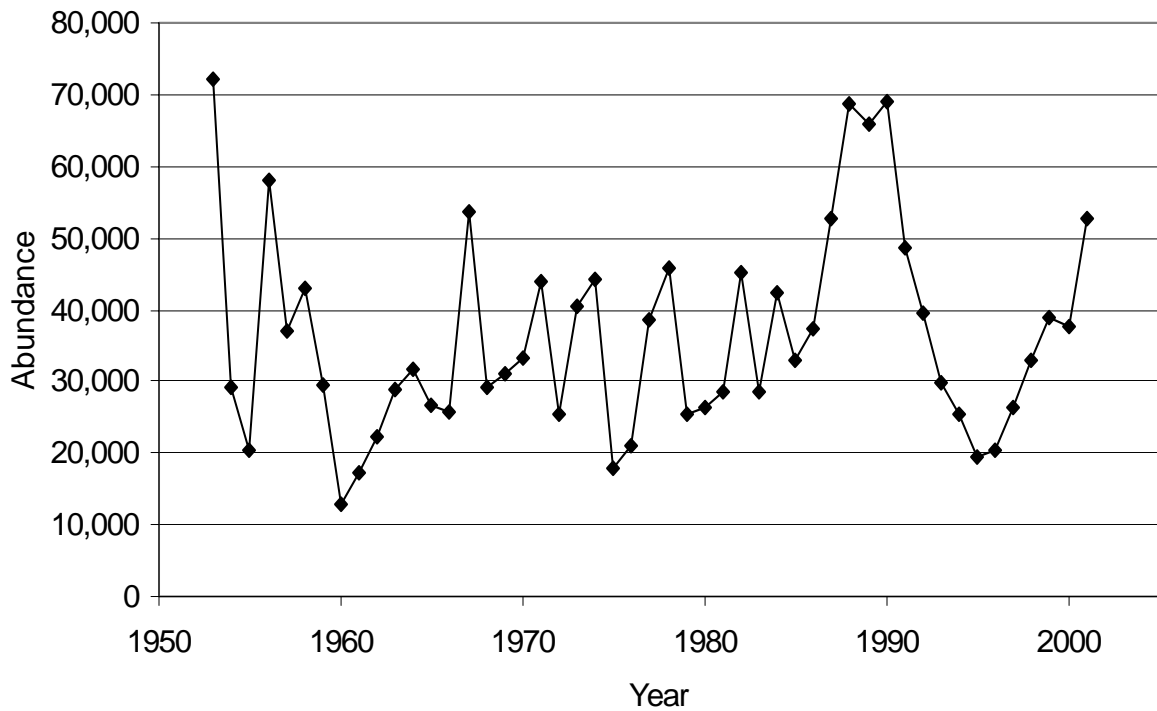


Figure A.2.6.2. Counts of spring-run chinook passing Willamette Falls. The count is of mixed natural and hatchery origin, with the majority of fish likely of hatchery origin.

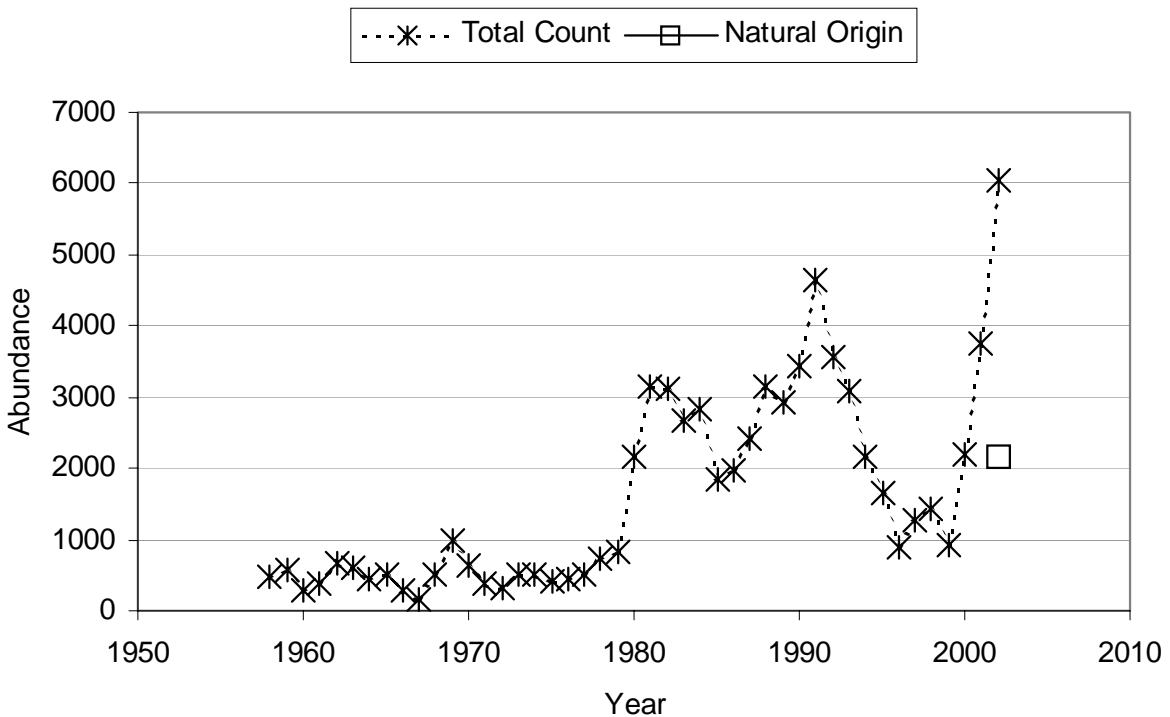


Figure A.2.6.3. Counts of spring-run chinook passing North Fork Dam on the Clackamas River (Cramer 2002). The total count is all fish passing above the dam. There is only one estimate (in 2002) of the number of fish passing above the dam that are of natural origin.

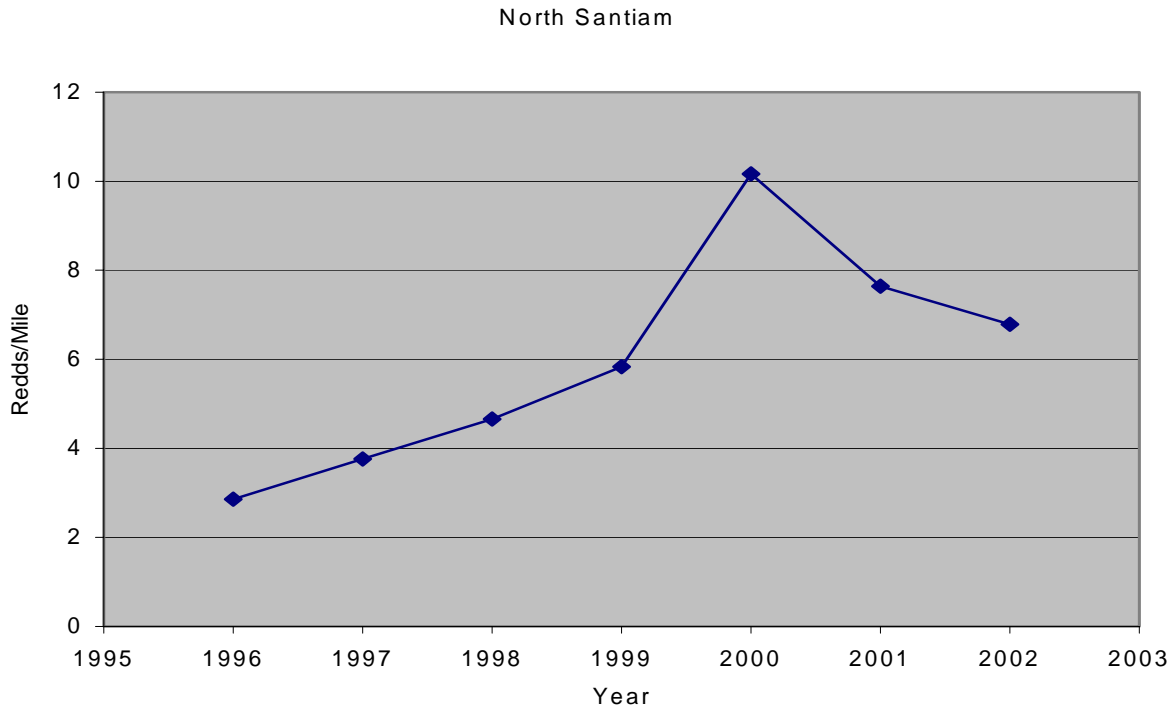


Figure A.2.6.4. North Santiam redds per mile (data from Schroeder et al. 2002). The number of stream miles surveyed varies between 26.8 and 43.5 miles. The total redds counted in a year varies between 116 and 310. Over 95% of the spawners are estimated of hatchery origin

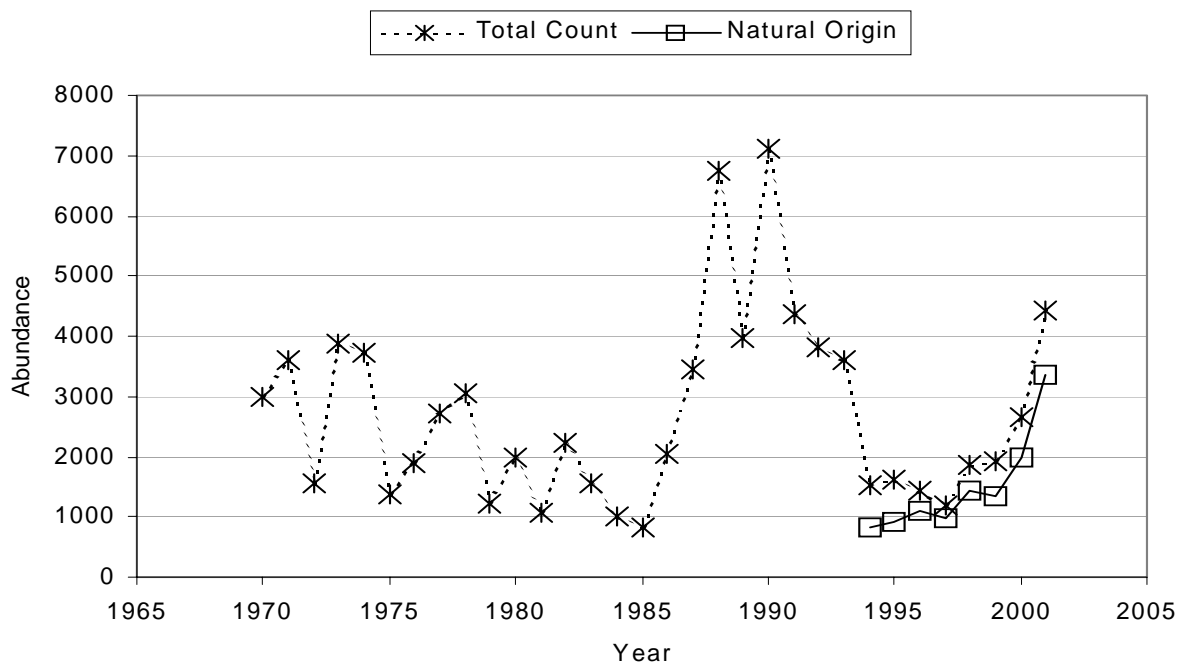


Figure A.2.6.5. Counts of McKenzie River spring-run chinook at Leaburg Dam.

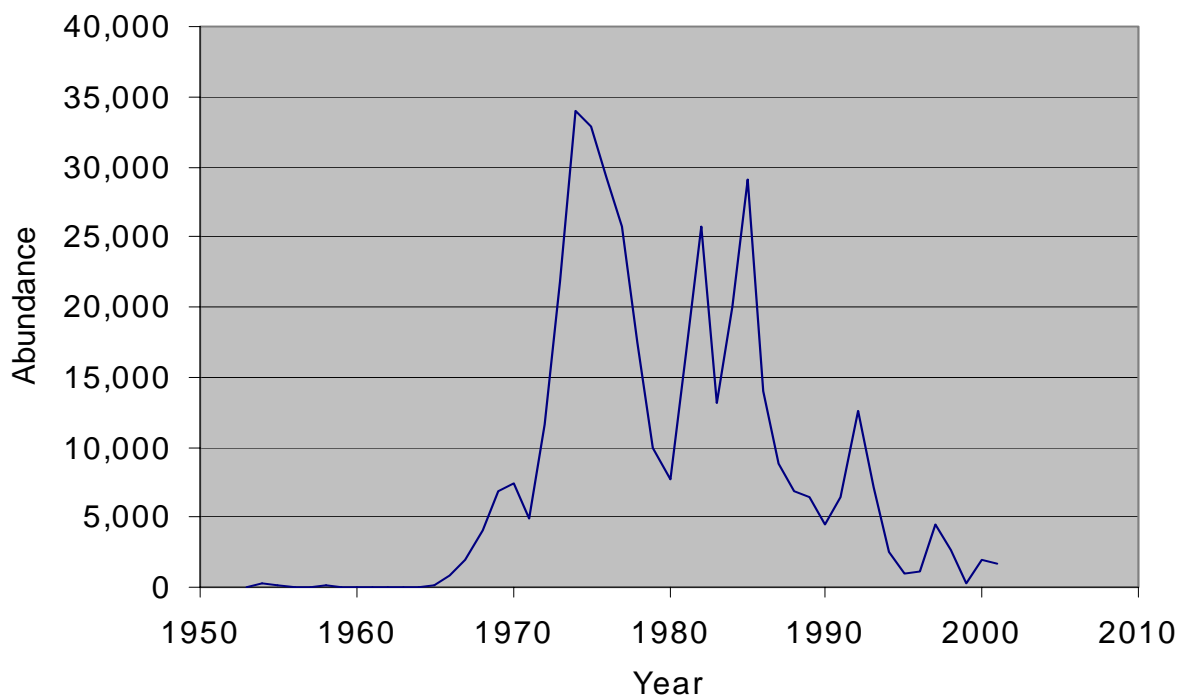


Figure A.2.6.6. Counts of fall-run chinook at Willamette Falls. Fall-run chinook are not native in the Upper Willamette River and are not in the in the Upper Willamette chinook salmon ESU.